The Marine Engineer

AND NAVAL ARCHITECT.

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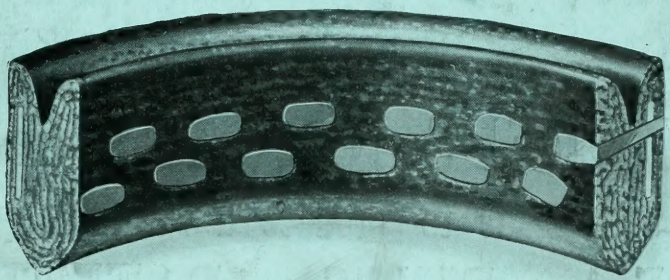

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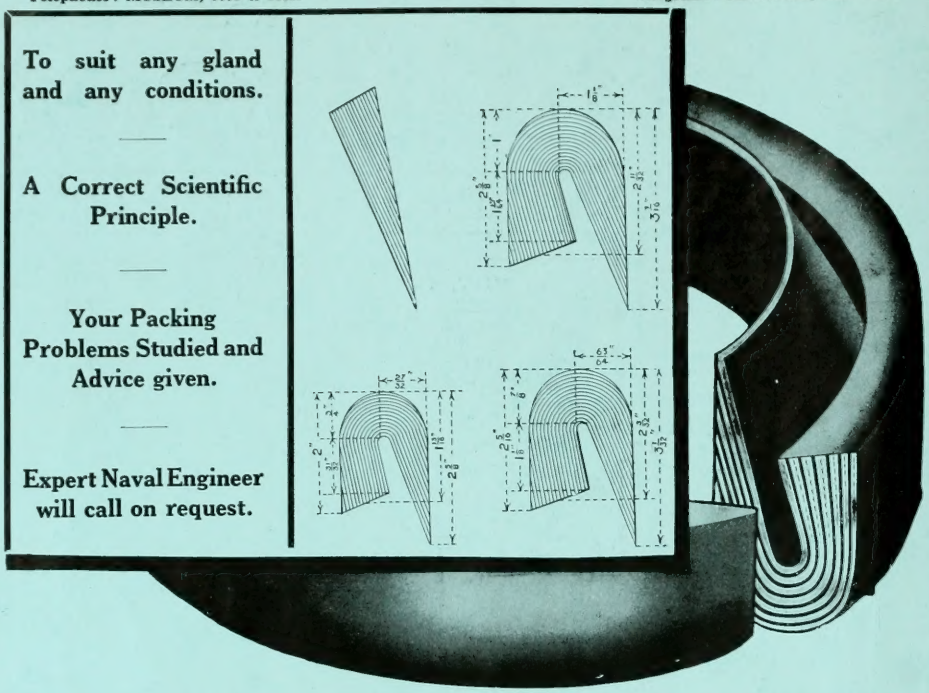

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The Editor will be glad to consider original articles and paragraphs on all subjects indicated by the title. Short practical articles based on the sender's own experience and illustrated by photographs or drawings are desired.

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Mr. Arthur Scholefield has been elected Chairman of the Oil Fuel Sub-Committee of the Tyne Improvement Commission in place of Mr. H. P. Everett, resigned.

Mr. P. Engberts, Naval Architect of the Lobith Shipbuilding Company, Lobith, has been appointed Naval Architect of the Chantiers Navals Franco-Belges, Paris.

Mr. Samuel Tagg, Engineer and Manager of the Preston gas undertaking, has been elected President of the Institution of Gas Engineers at its recent annual meeting held at Belfast.

Vickers-Petters Ltd., heavy oil engine manufacturers, Ipswich, have appointed Mr. A. P. Laughland to be their Midland representative. His offices are situated at Union Chambers, Temple Row, Birmingham.

Mr. Henry Joseph Hodgson, of Bootle, Lancs, Director of C. & H. Crichton (1921) Ltd., marine engineers, Derby Road, Liverpool, who died in March last, left estate of the gross value of £2,147, with net personalty £2,049.

Dr. Ir. Gustav Wrobbel, principal Naval Architect of the Lobith Shipbuilding Company, Lobith (Holland), has been appointed technical Managing Director of the Deutsche Schiffbau Aktien Gesellschaft.

Captain Lionel Manning, of the R.M.S. *Hibernia*, of the London Midland & Scottish Holyhead-Kingstown steamers, has retired after 40 years' service. He was in command of the *Anglia* when she was sunk during the war. Captain Telfer will probably be the new commodore of the fleet.

At the Board of Trade Surveyors' Office, North Shields, Mr. George Wishart, Engineer and Ship Surveyor, was presented by his colleagues with an oak smokers' cabinet, on the occasion of his transfer to Southampton, after over 17 years' service on the North Shields staff.

The Royal Commissioners for the Exhibition of 1851 Post Graduate Research Scholarship in Naval Architecture (1923), valued at £250 per annum for two years, has been awarded, on the recommendation of the Council of the Institution of Naval Architects, to Mr. Ebenezer Smith, B.Sc., of Glasgow University.

Sir John Henry Brunel Noble, M.A., had the honour of a baronetcy conferred upon him in the King's Birthday Honours List. He is the third son of the late Sir Andrew Noble, who for many years was head of the firm of Sir W. G. Armstrong, Whitworth & Co. Ltd. He is now Vice-Chairman of the company, and a director of numerous large industrial undertakings.

Commander A. K. Atkins, of the United States Navy, and Assistant Director of the United States Shipping Board, left for New York on July 17, on the ss. *Leviathan*, having been recalled to the service. Commander Atkins came to this country three years ago as Manager of Ship Repairs and Operations Department, and was afterwards appointed to the post which he now vacates.

Mr. Danchert Smith, member of the firm of Arnesen Christensen & Smith, of Christiania, Newcastle-on-Tyne and Cardiff, naval architects and consulting engineers, who have a large clientele among Scandinavian shipowners, has recently been made a Doctor of Science, with highest honours, at the Technical University of Danzig. This degree was awarded on his paper "Torsional Strength of Ships," which gave the results of exhaustive tests carried out on ship models built for the purpose.

In connection with the organisation of the marine engineering department of the General Electric Company, Schenectady, U.S.A., some new appointments have been announced by the Vice-President, Mr. Francis C. Pratt, as follows:—

Mr. M. W. Day, to be Engineer; Mr. W. L. R. Emmet, Consulting Engineer; R. A. Beekman, Assistant Engineer, giving attention to marine appliances and ship auxiliaries; Mr. W. C. Watson, Assistant Engineer, giving particular attention to ship propulsion, formerly in charge of propulsion; Mr. C. P. Turner, to be Administrative Assistant.

Mr. Walter Alexander has resigned as Executive Engineer for the Gibbs Brothers, naval architects, New York, to become Superintending Engineer of the Atlantic Refining Company, Philadelphia. Mr. Alexander started his engineering career on the Clyde, later joining the old American Line, being chief of some of their vessels. For a time he was Assistant Superintendent at the Tietjens and Lang Dry Dock, later going with the Harland & Hollingsworth Company, Wilmington, Delaware, as Engineer Superintendent. He was also Chief Engineer of the American Bureau of Shipping, leaving the Bureau to become Chief Engineer for the Gibbs Brothers, where he had entire charge of the engineering department on the *Leviathan*, and for the fine showing that vessel has made on her trials Mr. Alexander should have the greatest credit. He is considered one of the leading engineers in America.

EDITORIAL.

THE MARINE ENGINEERING SITUATION.

LLOYD'S Register Shipbuilding Returns for the quarter ended June 30, 1923, were published in July, and, according to our usual custom, we are in this issue reviewing these statistics from the point of view of the marine engineer. Table I below shows for each of the principal shipbuilding countries the number and tonnage of steam and motorships commenced during the quarters ending June 30, 1923, March 31, 1923, December 31, 1922, September 30, 1922, respectively. From this it will be seen that the quarterly increase of motorships commenced in the United Kingdom, to which we referred in our comments on the subject in our May issue, has been maintained, since, during the last quarter, work was commenced upon 18 vessels with a total gross tonnage of 90,515, as against 10 with a total gross tonnage of 48,024 during the preceding quarter. In parentheses, too, it is interesting to contrast the first of these two sets of figures with the corresponding figures for the June quarter of last year, which showed only 5 motorships commenced with a total gross tonnage of 810. On the other hand, the number of steamships commenced during the last quarter has fallen from 110, with a total gross tonnage of 303,949, to 52, with a total gross tonnage of 148,123. This, of course, can hardly be taken as a direct indication that the motorship is beginning to usurp the place of the steamship in the United Kingdom, although it seems certainly to be making good

Table I.—Showing Steam and Motorship Tonnage Commenced during Quarters Ending :—

Country.	June 30, 1923.		March 31, 1923.		Dec. 31, 1922.		Sept. 30, 1922.	
	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.
United Kingdom :								
Steamers	52	148,123	110	303,949	64	199,307	30	66,908
Motor vessels	18	90,515	10	48,024	5	30,260	3	15,200
Denmark :								
Steamers	3	5,305	8	11,916	2	2,060	1	960
Motor vessels....	1	4,350	1	107	4	10,610	3	7,605
France :								
Steamers	4	9,730	9	48,830	2	14,800	2	5,800
Motor vessels....	—	—	—	—	9	3,900	—	—
Holland :								
Steamers	—	—	2	2,900	5	4,400	—	—
Motor vessels....	—	—	2	360	—	—	—	—
Italy :								
Steamers	—	—	—	—	2	7,300	—	—
Motor vessels....	—	—	—	—	—	—	—	—
Japan :								
Steamers	11	11,350	5	5,530	12	12,234	10	16,120
Motor vessels....	—	—	—	—	—	—	—	—
Norway :								
Steamers	10	6,727	10	5,145	3	4,744	5	6,689
Motor vessels....	—	—	4	725	—	—	—	—
Sweden :								
Steamers	1	600	2	2,050	1	1,450	1	850
Motor vessels....	2	6,000	3	11,300	—	—	2	13,260
America :								
Steamers	6	16,800	18	50,756	10	42,350	10	48,400
Motor vessels....	3	6,000	7	18,200	1	1,000	—	—

headway. With regard to other countries, Holland and Italy have laid down no motorships recently. Japan, it would seem, has not yet started to build motorships, but her steamship returns show 11 vessels with a total gross tonnage of 11,350, *i.e.*, an average gross tonnage of 1,032. The Swedish returns show that the confidence of that country in motorships is still as strong as ever, although the weight of tonnage laid down is not very great. Norway did not lay down any motor tonnage whatever, and her steamer tonnage shows only an average of just over 600 tons. It will be seen, then, that on the whole the returns for the past quarter are less gratifying than those of the preceding quarter from both the marine engineering and shipbuilding point of view. Table II below summarises the total tonnage for all countries on which work was commenced during each of the quarters mentioned, and it gives also figures showing the motorship percentage of the total. From this it will be seen that there is an increase in the motor tonnage percentage of exactly the percentage figure for the previous quarter, and that it is, moreover, the highest figure for the past three quarters. This seems to indicate clearly the increasing

Table II.—Showing Percentage of Motorships of Total Tonnage for all Countries.

	Quarter Ending :—			
	Sept. 30, 1922.	Dec. 31, 1922.	March 31, 1923.	June 30, 1923.
	Tons.	Tons.	Tons.	Tons.
Steam	148,297	291,995	443,716	202,515
Motor	36,875	41,870	79,616	107,015
Motorship percentage of Total	20	12·5	15·2	30·4

popularityof the motorship in the world's shipbuilding countries taken as a whole. Furthermore, it is interesting to note, in the *resumé* of the Returns, the statement that " the tonnage of vessels now building in the world which are to be fitted with internal-combustion engines amounts to 387,936 tons, equal to over 18 per cent. of the steam tonnage under construction." There are also under construction in the world for the carriage of oil in bulk 31 steamers and motor vessels, each of over 1,000 tons, with a total tonnage of 178,780.

WATER LUBRICATION AND SUPERHEATED STEAM.

WE commented in these columns, in our June issue, upon the importance of internal lubrication in steam reciprocating engines, and it was conceded that with superheated or dry steam some form of internal lubrication to moving parts was necessary. The opinion has recently been expressed, however, that oil lubrication of steam distribution valves and pistons of marine steam engines, working under superheated steam, is not only detrimental to the heating surfaces of the boilers, unless there be an efficiently working oil-separating plant in the feed system, but that it is also unwise by reason of the possible danger caused by over-heating the superheating arrangements, through oily deposits on the steam side of the superheater pipes. However sparing in the use of his lubricating oil the engineer may be, the above-named objection still remains, and in view of these facts responsible men in engine-rooms are looking round for means by the use of which they may be overcome. For reciprocating engines, working with saturated steam, the water content is in most cases sufficient to act as a lubricant on the rubbing surfaces, and when using dry or superheated steam, an oil of high lubricating quality is often employed to form an oily film between the sliding surfaces without causing an oil cake-deposit between those surfaces, exposed to the high temperatures of the steam, as we pointed out.

On some Dutch steamers experiments have been made with a water-lubricating arrangement, in which a water jet is

continually injected into the superheated steam inlet side of the engine, through a $\frac{3}{8}$-in. pipe, connected to the delivery side of the main feed pump. Results have shown that notwithstanding the relatively large quantity of water delivered to the H.P. valve chest, the temperature of the superheated steam remains practically unaffected.

This fact, how improbable it may seem, is to be attributed largely to the spheroidal state of the water, which is suddenly exposed to a temperature far above its initial temperature. When surrounded by superheated steam of 200° Centigrade, the injected charges of water, finely divided by the velocity of the steam, are covered by a film of saturated steam, which prevents them from being evaporated suddenly in the surrounding medium of steam at a high temperature. In this way it is possible for the water to reach the valve and piston surfaces, and the water, if injected in large enough a quantity, should be sufficient for lubricating purposes. We should imagine that in the case of reciprocating engines working with superheated steam much wear and tear on cylinder liners and consequent sticking of H.P. piston rings will be eliminated by the adoption of this system. Considered from this point of view, too, it is clear that hot bulb motors, working with water injection, are capable of developing so much more power than by oil-piston lubrication alone, because of the more efficient cooling and lubrication of the cylinder walls.

THE IMPORTANCE OF EFFICIENT CONDENSERS.

THE extent to which the steam turbine is used at the present time for the propulsion of ships makes the problem of efficient condenser design one of the greatest importance. It is generally recognised by marine engineers that the best results from a steam turbine can only be obtained when the steam is allowed to expand to the lowest possible pressure before passing through the exhaust to the condenser, and hence, on turbine ships, it is customary to instal condensers which are capable of producing a higher vacuum than is the case on ships fitted with reciprocating engines. The production of an extra half-inch in the condenser vacuum will result in a large increase in the power developed by the turbine, and it has become the practice to run the condensing plant on turbine ships so that the vacuum approaches to within about 1 in. of barometric height, or, on an average. to about 29 in. of mercury, while on vessels fitted with reciprocating engines, a 26-in. or 27-in. vacuum is generally considered as representing the limit above which it is not economical to proceed.

Considering the condensing plant as comprising the condenser itself with merely its circulating pump and air pump, an increase in the vacuum can be obtained by increasing the size of the condenser or by fitting a larger air pump when dealing with a given quantity of exhaust steam. Merely increasing the size of the circulating pump tends to lower the temperature of the condensate with corresponding loss of efficiency of the boiler; although in dealing with a larger condenser a correspondingly larger circulating pump will, of course, be required. Hence, to produce a higher vacuum, we shall be faced with a larger expenditure of steam in both the air pump and the circulating pump, and the question arises as to how far these increases can be met before the saving in consumption in the main turbine is balanced by the increased consumption in the condenser auxiliaries. In addition to the factor of steam consumption, there is also the question of the increased weight and cost of the plant to be set against the saving in the cost of running it, and this is a point which must not be lost sight of when dealing with the increase in the size of auxiliary machines for any particular purpose. Although no definite data are available as to when the simple condensing arrangement referred to above ceases to be economical, it is realised that in the production of high vacua some additional means must be adopted. In measuring condenser performance there are so many variable quantities to be taken into account that it is a difficult matter to find a common denominator in terms of which the performance of any plant may be expressed. Neglecting the question of the prime cost of the different systems, we might determine the number of pounds of steam condensed per pound of steam employed in the auxiliaries; but it must be remembered that these figures will only be of value when the pressure of the steam used in the auxiliaries is considered. Again, the temperature of the circulating water will materially affect the result, while the pressure, and hence the temperature at which the exhaust steam is condensed, must also be considered. But it is apparent that merely to say that a condensing system is capable of giving a vacuum of so many inches, or so much per cent. of barometer, is not sufficient unless some indication is also given of the expense in steam consumption, and in other terms, with which this vacuum is obtained. The growing importance of the steam turbine for merchant ship propulsion, and the consequent demand for condensing plant capable of yielding high vacua, renders it almost imperative that some means of expressing the efficiency of the performance of condensing apparatus should be devised.

From the "Marine Engineer," August, 1879.

The Status of Naval Engineers.—We are glad to see that the scientific and consequently improved social position of marine engineers of the Royal Navy is now meeting with better consideration at the hands of the Admiralty. A notice of competitive examinations for engineering studentships in Her Majesty's dockyards has been inserted for some time during the commencement of the year. Forty vacancies were filled up in May last, and the number of applicants far exceeded the vacancies offered. Again, the Admiralty and the Committee of Lloyd's have each established a scholarship of £50 a year, tenable for three years, to be competed for by the students of the Naval College. If the Admiralty is now taking so much trouble to secure a marine engineer of the future, who shall have undergone a specified scientific and practical training, there will no longer be any possible or valid excuse to withhold from them, as a class, an equal social recognition with their confrères of the service.

The Demand for Speed.—Although there was this year no China Tea race, the new Glen liner, *Glencoe*, has made the fastest passage on record. Leaving Woosung, at the mouth of the Shanghai river, on May 27, she arrived off Gravesend in the extraordinary short space of 37 days out, viz., on July 3. That is certainly a most astonishing passage, but one of the most striking features of the age is the ever-increasing demand for speed. It is curious to compare such a result as that we have just instanced with the doubt and hesitation of Mr. Brunel and Dr. Lardner as to whether steamships could be constructed to cross the Atlantic. This problem was first settled in 1838, when the *Sirius* from London, and the *Great Western* from Bristol, made their successful voyage to New York.

"Aha."—On July 3 there was launched from the shipbuilding yard of H. M'Intyre & Co., Paisley, a screw-steamer schooner yacht, named the *Aha*, of the following dimensions:—Length, 50 ft.; breadth, 12 ft.; depth, 6 ft. She was built to the order of Captain Sadler, of the screw steamer *State of Indiana*, for the purpose of illustrating the advantages of deep immersion of the propeller. She is fitted with a lifting and lowering propeller, which is so arranged that it can be lowered almost its half diameter below the keel, or it may be lifted up clear of the water altogether, so that in a fair wind, when the sails are set, it will offer no obstruction to the speed. She is fitted with Ferguson's patent triple-action engines, which admit of the shaft being only a few inches above the keel, and are the lightest and most compact engines known in proportion to the power they develop. The engines are constructed by Fleming & Ferguson, of Paisley, and are intended to indicate 70 h.p.

BOOKS FOR THE MARINE ENGINEER AND NAVAL ARCHITECT.

Brief Reviews of Recent Publications.

"The Journal of the Institute of Metals." Volume XXIX. Edited by G. Shaw Scott, M.Sc. London: Institute of Metals, 36-38, Victoria Street, S.W.1. 6 in. × 8½ in. × 1¾ in. 914 + x pp. Numerous plates and figures in text. Price 31s. 6d. net.

Another large volume of metallurgical information has just been issued by the Institute of Metals. The new book deals comprehensively with the annual meeting held in March last, covers over 900 pages, and is illustrated by 57 plates.

It includes more papers than have ever before appeared in one of the Institute's volumes. There are 20 papers in all, covering every phase of metallurgical work, and nearly every alloy. Any alloy that escapes mention in the papers is to be found in the abstracts section of the Journal. The latter section is very valuable to all workers in and users of metals—as, in fact, is the whole book.

Calculations in Heating and Ventilation. By G. S. Coleman, D.Sc., Assoc.M.Inst.C.E. London: Longmans, Green & Co., 37, Paternoster Row, E.C.3. 6 in. × 8½ in. × 1 in. 255 pp. Price 15s. net.

This book is the result of the lack of a suitable text-book which provides working examples in the subject under consideration, and it is intended to assist students in obtaining practice in the calculations connected with the heating and ventilation of buildings. The author has included such portions of applied mechanics, physics, hygiene, hydraulics and pneumatics as he considers will be required, and has continued with chapters dealing with the data required, the experimental coefficients and the derivation and accuracy of certain standard formulæ. Further chapters relate to ducts, pipes, fans, boilers, chimneys and fuels, and the methods are illustrated by worked examples in the text. Numerous examples for the use of the student are given at the end of each chapter, and numerical answers are supplied. While the book is not intended primarily for marine engineers, the latter will find a tremendous amount of useful information contained therein.

Machine Drawing. By Carl Svensen, M.E., Assistant Professor of Engineering Drawing in the Ohio State University. London: Scott, Greenwood & Son, Broadway, Ludgate Hill, E.C.4. 6½ in. × 9½ in. × ¾ in. 214 pp. 338 illustrations. Price 12s. 6d. net.

Machine drawing in a great many cases proves the bugbear of the engineering student in some of his earlier examinations. Too much attention in fact cannot be given to obtaining a thorough grasp of the subject initially. Mr. Svensen may be said therefore to have embarked upon an important task when he set out to "make available a guide for the development of an understanding of the relation of machine drawing to engineering." The book is well produced and it contains a number of good illustrations; it is, in fact, quite a sound treatise on the subject.

The Causes and Prevention of Corrosion. By Alan A. Pollitt, M.Sc. (Tech.). London: Ernest Bean Limited, 8, Bouverie Street, E.C.4. 7½ in. × 10 in. × ¾ in. 230 + ix pp. Price 25s. net.

The title of this book introduces a subject of great importance in the engineering world. We dealt at some length in our columns in the July issue* on some of the theories of corrosion. Here is a book in which the author states that "whilst the subject of corrosion is by no means unrepresented in technical literature, particularly much of it is, unfortunately, scattered." The author has therefore prepared a book to deal with the more interesting and practically useful information on the various phases of the subject. There is an interesting section dealing with the theory of corrosion, followed by one on the causes of corrosion, after which the author goes on to discuss the prevention of corrosion. Marine engineers will find the pages dealing with feed water treatment very useful.

* "Condenser Tube Corrosion," by R. Le Boysson.

Workshop Routine. By W. J. Hiscox. London: Chapman & Hall, 11, Henrietta Street, Covent Garden, W.C.2. 5¾ in. × 8⅞ in. × 1 in. 158 pp. Price 9s. 6d. net.

This book is another of the well-known Directly Useful series, and it deals, moreover, with a subject which is dealt with very little in technical literature. The author in his preface states that he discusses, as a factory man, workshop routine from the standard of things as they are rather than of what they should be. The work is divided into two parts, Part I dealing with principles of organisation and Part II with standing instructions. The letterpress makes very interesting reading, and contains a great deal of useful information.

Die Maschinen der Flussfahrzeuge und der Kleineren Seeschiffe, deren Kessel und Hilfsmaschinen. By Oberingenieur Siegbert Welsch. Berlin: Zeitschrift "Schiffbau," Neuenburger Str. 8. 5⅝ in. × 8¾ in. × ½ in. 315 pp.

This book is a typical German production with its paper covers, and profuse illustrations, but the marine engineer who is also a student of the German language will find 313 pages very full of information. The machinery of river steamboats and of small seagoing ships, their boilers and auxiliary machinery, is dealt with in nine chapters, and the letterpress includes sections on main propelling machinery, condensers, thrust blocks, boilers, pumps, feed-water heating, &c.

The Dock and Harbour Engineers' Reference Book. By Bysson Cunningham, D.Sc. London: Charles Griffin & Co. Limited, Exeter Street, Strand, W.C.2. 4⅜ in. × 6½ in. × ¾ in. Second edition, revised. 319 pp. 140 illustrations. Price 9s. net.

This book is the second edition of a little work published first in 1914. It contains a great deal of useful information to all concerned in harbour construction and maintenance. The notes contained therein are mostly extracts from literature dealing with the section concerned, and they deal with practically every phase of the subject.

TRADE PUBLICATIONS.

Brittain's Electric Motor Company, 110, Cannon Street, E.C.4, have sent us a copy of their latest catalogue and price list.

The Scarab Oil Burning Company Limited, Carlton House, Regent St., W., have issued a booklet entitled "The Problem of Heat Oxidization of Metals Economically Solved."

Sports and Sportsmen Ltd., 48, Russell Square, W.C.1, have published a booklet entitled "Propelling a Cargo Boat," by D. B. Morison, M.I.N.A. The substance of the book is an article bearing the same title as the booklet which appeared in "The Story of Shipping," which was also published by Sports and Sportsmen Ltd., some little time ago. The booklet contains 52 pages, and of these the first 16 are occupied by the article, the remainder containing some excellent illustrations of the products of Richardsons, Westgarth & Co. Ltd.

PRISMATIC COEFFICIENTS OF ENTRANCE AND RUN.

Their Determination from Empyrical Formulæ.

In the preliminary stages of a design the position of the centre of parallel body may be obtained from McEntee's results, and the percentage length of parallel body from Taylor's Series, if the speed, length, and prismatic coefficient are known quantities. The position of the longitudinal centre of buoyancy will be given by the design of the vessel, and the appropriate coefficients for the entrance and run must then be found in order that a complete curve of areas may be drawn. It is desirable that these prismatic coefficients of entrance and run be easily determined, and several formulæ exist for this purpose. An empirical formula has been devised, based on the assumption that the percentage distance of the centre of gravity of the entrance or run, from the forward or after end of the parallel body, bears a constant ratio q to the prismatic coefficient of the entrance or run respectively.

Let L = length of ship,
A = area of midship section,
V = volume of displacement,
γ = total prismatic coefficient of ship,
i.e., $V = A \gamma L$.

Assume mL = length of parallel body,
and x = distance of longitudinal centre of buoyancy aft of centre of parallel body.

If v_e, v_r be volumes of entrance and run respectively, and p_e, p_r be the prismatic coefficients of entrance and run respectively, then—

Distance of centre of gravity forward of end of parallel body $= q \times p_e l_e = \frac{q v_e}{A}$, q being a constant.

Similarly, centre of gravity of run is $\frac{q v_r}{A}$, aft of end of parallel body.

Take moments about the centre of parallel body.

$$V x = v_r\left[\frac{m L}{2} + \frac{q v_r}{A}\right] - v_e\left[\frac{m L}{2} + \frac{q v_e}{A}\right]$$

$$= [v_r - v_e]\frac{m L}{2} + [v_r^2 - v_e^2]\frac{q}{A}$$

whence $x = \frac{v_r - v_e}{V}\left[\frac{m L}{2} + \frac{q}{A}(v_r + v_e)\right]$ .....(1)

Now $v_r + v_e$ = (volume of ship) − (volume of parallel body)
$= V - A\, m L = A(\gamma L - m L)$ .....(2)

Substitute for $(v_r + v_e)$ in equation (1), then—

$$x = \frac{v_r - v_e}{V}\left[\frac{m L}{2} + q(\gamma L - m L)\right]$$

$$= \frac{v_r - v_e}{A \gamma L}\left[L\{q\gamma - m(q - \tfrac{1}{2})\}\right]$$

whence $v_r - v_e = \frac{A \gamma x}{q\gamma - m(q - \frac{1}{2})} = \frac{A x}{q - \frac{m}{\gamma}(q - \frac{1}{2})}$ .....(3)

From equations (2) and (3),

$$p_e = \frac{v_e}{A l_e} = \frac{1}{2 l_e}\left[(\gamma - m)L - \frac{x}{q - \frac{m}{\gamma}(q - \frac{1}{2})}\right]$$

and

$$p_r = \frac{v_r}{A l_r} = \frac{1}{2 l_r}\left[(\gamma - m)L + \frac{x}{q - \frac{m}{\gamma}(q - \frac{1}{2})}\right]$$

giving the required prismatic coefficients.

The mean value of q, over a range of prismatics from ·5 to ·8, for a large number of curves of areas of entrances and runs, has been found to be ·55.

The formulæ then reduce to—

$$p_e = \frac{1}{2 l_e}\left[(\gamma - m)L - \frac{20x}{11 - \frac{m}{\gamma}}\right]$$

$$p_r = \frac{1}{2 l_r}\left[(\gamma - m)L + \frac{20x}{11 - \frac{m}{\gamma}}\right]$$

The position of the longitudinal centre of buoyancy, using given prismatic coefficients of entrance and run, may be determined from—

$$x = \cdot 05\ [l_r p_r - l_e p_e]\left[11 - \frac{m}{\gamma}\right]$$

In most high-speed warships and fast liners there is no parallel body, and prismatic coefficients may be obtained from

$$p = \frac{1}{2 l}\left[\gamma L \pm \frac{20 x}{11}\right]$$

The attached table shows the values of q obtained for a few different forms :—

Form.	Prismatic Coefficient.	Distance of Centre of Gravity.	Ratio q.	Remarks.
Circle	·785	·425	·542	
Parabola	·667	·375	·560	
Sine curve	·637	·363	·570	
Baker's forms—				
1	·720	·384	·534	
2	·672	·361	·537	Hollow line bow.
3	·672	·365	·545	Medium line bow.
4	·672	·372	·554	Straight line bow.
5	·625	·345	·552	
6	·578	·328	·567	
7	·638	·361	·566	Straight line stern.
8	·638	·351	·550	Medium line stern.
9	·638	·344	·54	Hollow line stern.
10	·700	·375	·536	
Warship forms	·611	·335	·548	
	·593	·331	·558	

To illustrate use of the formulæ the following example may be taken :—

Vessel 400′ × 52′ × 25′. Prismatic coefficient = ·775.
Length of parallel body (11 knots) = ·32 L = 128 feet.
Centre of parallel body = 14 feet forward.
Longitudinal centre of buoyancy = 4 feet forward, whence x = 10 feet.
Length of entrance = 122 feet.
Length of run = 150 feet.

To find prismatic coefficients of entrance or run,

$$p_e = \frac{1}{2 \times 122}\left[(\cdot 775 - \cdot 32)\,400 - \frac{20 \times 10}{11 - \frac{\cdot 32}{\cdot 775}}\right] = \frac{1}{244}$$

$$[182 + 18 \cdot 9] = \cdot 668$$

$$p_r = \frac{1}{2 \times 150}[182 - 18 \cdot 9] = \cdot 670.$$

Investigation will show that if an error of 5 per cent. had been made in the evaluation of the ratio q, the error in the prismatic coefficients would still be less than $\frac{1}{3}$ of 1 per cent. The formulæ may, therefore, be taken as sufficiently accurate for design purposes.

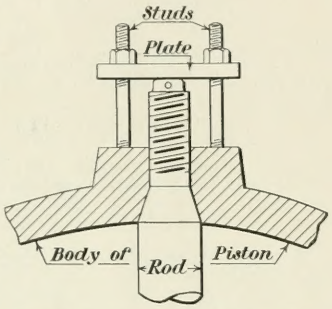
SOME NOTES ON ADJUSTMENTS AND REFITS TO MARINE RECIPROCATING MACHINERY.

Drawing Piston Rod—Fractured Crankshaft—Turning Piston Rings.

(*Continued from page* 245.)

No. 7.—Drawing Piston from Piston Rod.

This operation is a very frequent one, and in many cases, in addition to the method described below, heat has to be applied before the piston will move. If the ordinary heat gained from a waste fire is not sufficient, an iron tube should be used, this tube being made larger than the diameter of the bore of the piston. The iron tube is then heated and placed over the boss until it is possible to draw piston. The usual procedure is as follows :—The piston nut is removed and four studs (two only shown in sketch) are screwed into body of piston, as will be seen from the diagram. A plate is then fitted over these studs, this plate resting on the end of the piston rod. Nuts are then put on the studs and screwed up, and this draws the piston from the rod.



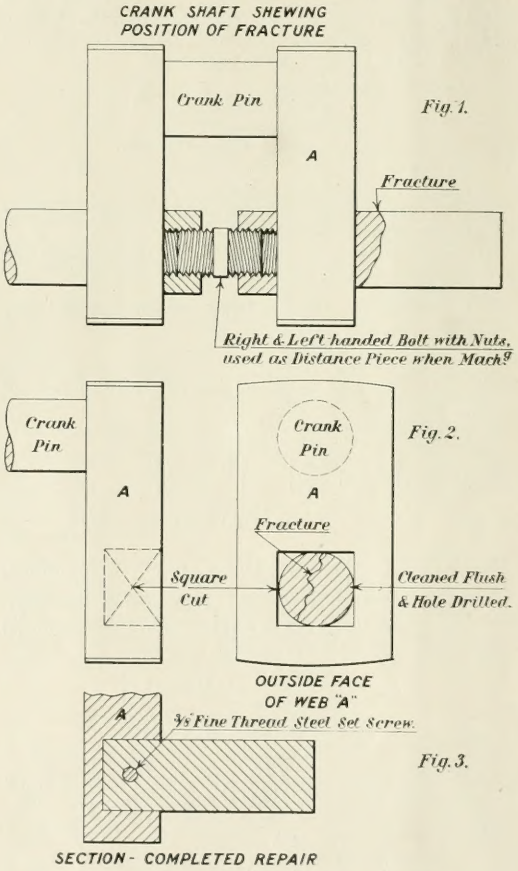
Sketch showing Method of Drawing Piston.

No. 8.—Refitting Carbon Packing.

In turbines of the Brown-Curtis type, the glands are packed with carbon rings, and are divided into inner and outer glands, two carbon rings being usually fitted in the outer and three in the inner. These carbon rings are made in segments, and are kept together by a coiled spring, and the leak-off cavity is arranged between the two glands. Although all segments are made to gauge and are interchangeable, if the number of spares allow, it is always better, when a new packing ring is required, to fit complete rings, a perfectly tight gland never being obtained with new and old segments. Care must be taken when handling the segments, as they are very brittle and easily broken at the laps ; also, great care must be taken that the segments do not butt when fitted in place, and each ring should be tried on the spindle when the glands are down. The gland and carbons should be removed in the following manner :—Place the make-up ring in position on spindle, and withdraw all the securing bolts of the outer gland, and the pins which prevent the outer gland carbons from turning. By means of the starting screws, start withdrawing the gland, and slew the outer gland until the longitudinal joint is horizontal. Next part the longitudinal joint by means of the withdrawing bolts, and lift away top half of outer gland, avoiding any motion which might damage the carbons. Disconnect the spiral springs, and withdraw also the protecting bands, and lift the top carbons. Then work the bottom carbons round the spindle from one side and remove them ; then slew the bottom half of the outer gland and lift it out ; the inner gland is now exposed. Withdraw the securing screw and the pins which prevent the inner gland carbons from turning, and insert the long temporary screws in the securing screw holes, so as to guide the inner gland during its removal. Start withdrawing the gland by means of the starting screws provided. Withdraw the inner gland far enough to clear the gland face of the turbine casing ; the same method of procedure must then be followed for the outer gland.

No. 9.—Repair to a Fractured Crankshaft.

The fracture occurred to a forced-draught fan engine crankshaft, at the point indicated in Fig. 1. To forge a new crankshaft would have been a long job, and, with the appliances carried on board the ship in question, the ultimate result would probably have been unsatisfactory, in addition to which very careful marking off and machining would have been necessary. Again, the repair would have taken a considerable time, and the air pressure in the boiler-room could not have been maintained with the one remaining fan. The following method of repair was, therefore, decided on. The part shown shaded, Fig. 1, was chipped and filed flush with the web A, care being taken to preserve the surface of the web outside

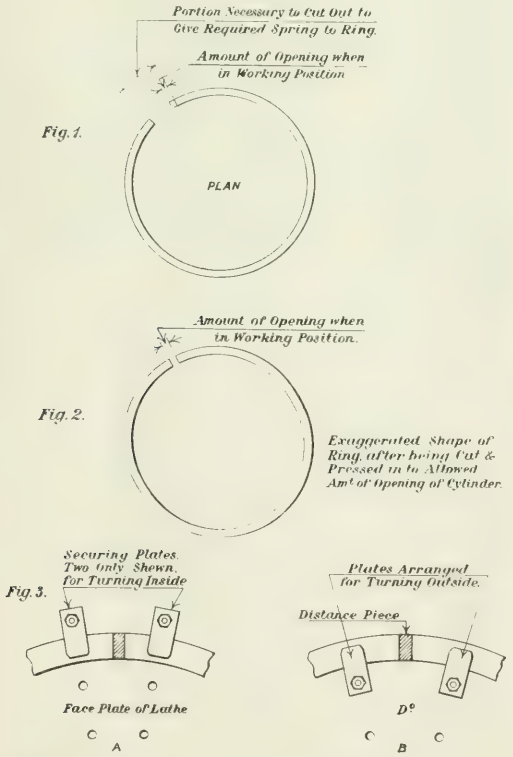


Sketch showing Method of Repairing Crankshaft.

the fracture. A hole was next drilled in the web face, as shown in Fig. 2. This hole extended about two-thirds into the web, as shown in Fig. 3. The hole was then chipped and filed out square, as shown. In the meantime a piece of steel was forged to suit as a new bearing pin in place of the fractured portion. This was rough turned to within $\frac{1}{4}$ in. finished diameter, to allow for final turning after fitting in place. A square was machined on the end, as shown in Fig. 2, enough metal being left to make it a driving fit in the square. The square end was next fitted into the square in web, a good tight driving fit being arranged for a third of the way in, the remainder of the square being left slightly big to allow for shrinking the crankshaft on. The crankshaft was then carefully heated, very great care being taken to prevent distortion. The new bearing end was then driven in hard home, and the whole allowed to cool; the next operation was to set up in the lathe and machine the new part to finished size. The crankshaft was set quite true, a distance bolt being secured between the webs when turning (see Fig. 1). The turning was successfully accomplished, and as an additional safeguard, a $\frac{3}{8}$-in. fine-thread steel set-screw was screwed in, as shown in Fig. 3. After six months' continuous running there were no signs of excessive wear or distortion of any part.

No. 10.—Turning Piston Rings.

Piston rings which rely on their "spring" for making a steamtight fit in the cylinder should always be machined in two operations, and for this reason all spare piston rings of

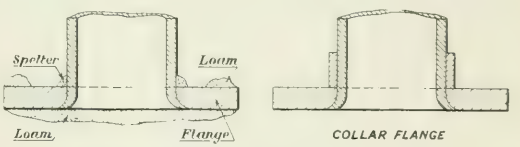

Portion Necessary to Cut Out to Give Required Spring to Ring.
Amount of Opening when in Working Position
Fig. 1.
PLAN
Amount of Opening when in Working Position.
Fig. 2.
Exaggerated Shape of Ring, after being Cut & Pressed in to Allowed Amt of Opening of Cylinder.
Securing Plates. Two Only Shewn. for Turning Inside
Fig. 3.
Face Plate of Lathe
A
Plates Arranged for Turning Outside.
Distance Piece
B

Sketch showing the Operation of Turning Piston Rings.

this type carried must be left big to allow for final turning, and spares should always be left uncut. The reason for machining in two operations is as follows:—To obtain the necessary spring, a considerably larger piece has to be cut out of the circumference of the ring than the allowed amount of opening when the ring is fitted on the piston in the cylinder (see Fig. 1). When, therefore, the necessary piece has been cut out, and the free ends brought together to within the allowed opening, the ring will not be a true circle, and an exaggerated view of the distortion is shown in Fig. 2; it will, in fact, be an inaccurate fit in the cylinder, with great possibilities of steam leakage from one side of the piston to the other. To obviate this, the following method of machining should be adopted, which, although a longer and more costly procedure, amply repays the extra work and cost in steam economy, and also in equal wear on the cylinder or liner walls. The procedure is as follows:—First cut out the necessary piece so as to give the required spring (this is usually marked on the drawing, if available, or can easily be calculated according to the ring metal). Next compress the ring to the allowed opening and fit a distance piece of this thickness. The ring, with distance piece, is then held on the face plate of the lathe, as shown in Fig. 3. Securing plates are used as shown at A for turning the inside, and, as shown at B, when turning the outside. It must be borne in mind that, after the inside diameter is bored to correct size, the securing plates as at B must be placed on and screwed up before removing the outer securing plates. When the turning is completed the distance piece is removed and the ring fitted in place.

No. 11.—Brazing a Flange to a Copper Pipe.

This is probably one of the most frequent of small repairs that a marine engineer is called upon to perform, the method of procedure being as follows:—The flange face is cleaned, and the end of the pipe to which flange has to be attached is annealed and cleaned. The flange is then carefully fitted on and riveted on the face of flange. It is then suspended over a fire and charged with spelter. To prevent overheating of the parts exposed to a higher temperature than the joint, "loaming" is resorted to. The pipe and flange are heated until the spelter melts and runs, borax being used as a flux. It is then taken from the fire, and as soon as the spelter sets, powdered common salt is sprinkled over the job, which is



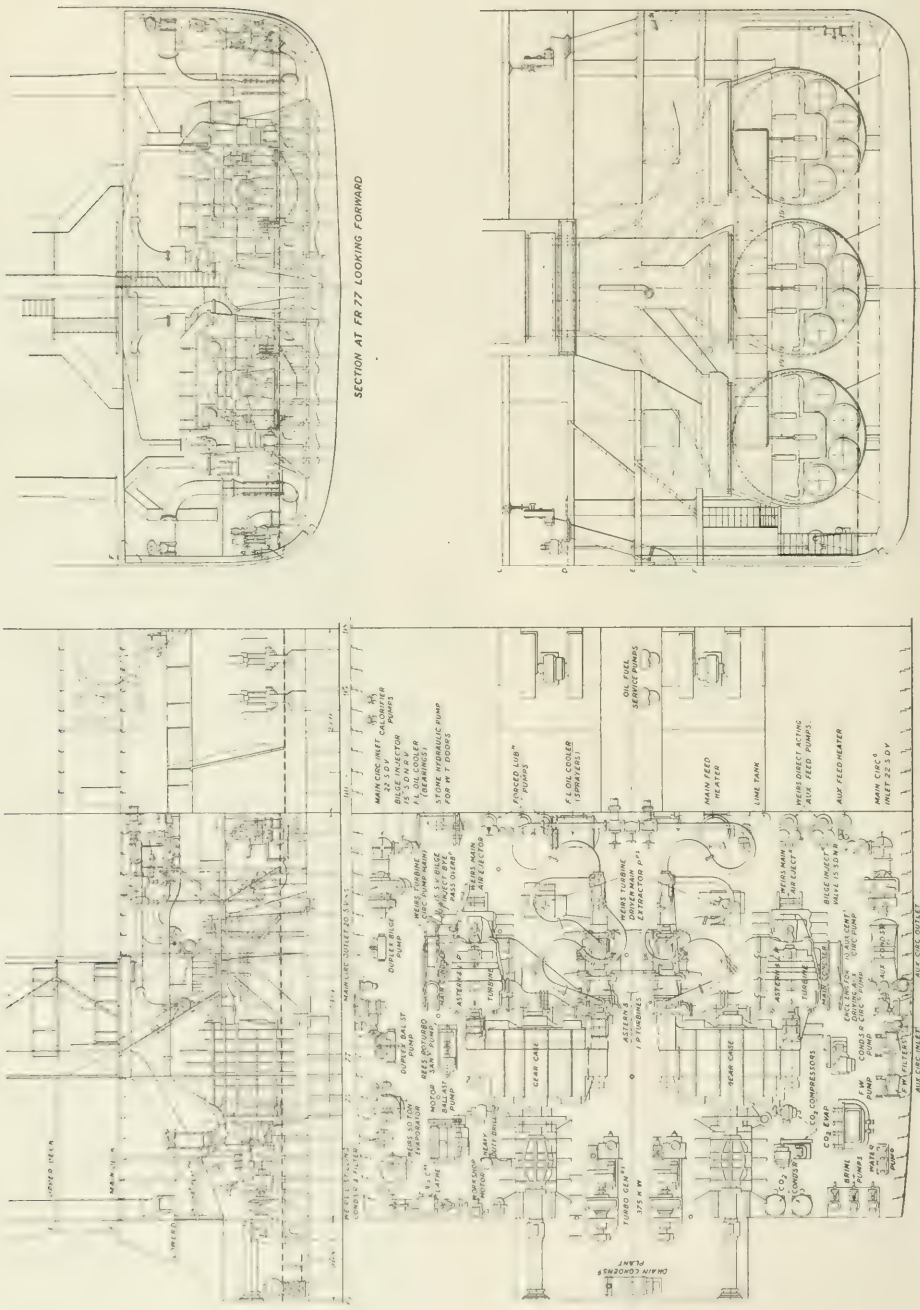
Sketch showing the Method of Brazing.

dipped in cold water, the salt cleaning the borax off. The composition of flanges and spelter respectively is as follows:—

Flanges—		
Copper	... ...	94 per cent.
Zinc	... ...	6 ,,
Spelter—		
Copper	... ...	43 per cent.
Zinc	... ...	57 ,,

Gunmetal flanges are unsuitable as the brazed joint is unreliable, and the flanges frequently crack in the fire. Collar flanges are fitted in order to increase strength of the brazed joint.

Thornycroft Successes.—The success of the technical classes held at the works of John I. Thornycroft & Co. Ltd., for training their engineering pupils, continues to be proved at the periodical examinations of the Institution of Mechanical Engineers. At the last one held in April six students, trained at the Basingstoke Works, were successful in passing the graduate examination, and in addition three were successful in passing the examinations for the Associate Membership.



The Cunard Liner "Franconia." General Arrangement of Machinery Space.

MODERN MACHINERY SPACES—V.

The Cunard Passenger Liner "Franconia," Built and Engined by John Brown & Co. Limited, Clydebank.

The latest addition to the Cunard Steam Ship Company's fleet of passenger-carrying vessels is the twin-screw ss. *Franconia*, which has recently completed her maiden voyage in the Liverpool–New York service. Strictly, she is a vessel of the intermediate type, although a departure has been made in her design from true intermediate status, in that she has been specially arranged internally for ocean cruising purposes. On this account the most important difference between the *Franconia* and the *Scythia*, first of the Cunard post-war intermediate fleet, is that No. 4 hold has been utilised for the installation of a squash rackets court, gymnasium, swimming bath, electric and other baths. The principal particulars and characteristics of the vessel are as follows :—

Length, extreme	623·75 ft.
,, b.p.	601·3 ft.
Breadth, moulded	73·7 ft.
Depth	45 ft.
Gross register tonnage	 20,000
Net ,, ,,	 12,000
General cargo space (permanent)	.... 240,000 cub. ft.
Insulated ,, ,,	.... 25,600 cub. ft.

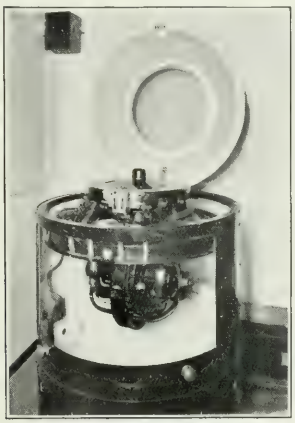
The vessel is classed 100 A 1 at Lloyd's, shelter deck with freeboard, special survey, and is approved by the British Board of Trade and the American authorities in all respects as a foreign-going passenger steamer.

General Arrangement of Machinery.

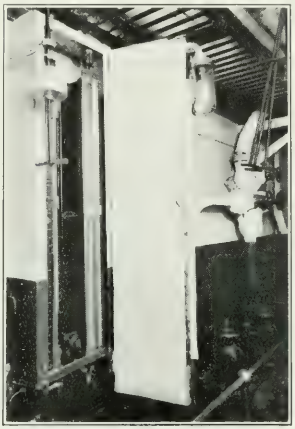
A general arrangement plan of the machinery space is shown on the opposite page. It will be seen that the vessel is propelled by twin sets of Brown-Curtis turbines driving their respective main shafts through double reduction gearing. The complete installation develops a collective shaft horse power of 12,500 with the propellers running at the rate of about 90 r.p.m. The total power developed for going astern is about 70 per cent. of the ahead power.

Main Turbines.—Each set of turbines consists of one high pressure and one intermediate pressure turbine in tandem driving through a flexible coupling one pinion, and a low pressure turbine driving through a flexible coupling the other pinion of the first reduction gearing, and then through the second reduction pinions, the gear wheel mounted on the main shaft. Each of the high pressure turbines is made up of three double-bladed discs having intermediate nozzle plates. There is arranged in the inlet pipe a valve, operable by means of a handwheel, and this covers the entrance to a nozzle through which steam may be passed directly to the exhaust. As has been mentioned, in each set the high pressure and intermediate pressure turbines are arranged in tandem and the steam after leaving the former is passed into the latter through two 9-in. pipes. There are eight discs in the intermediate pressure turbine, seven of which have single rows of blades, the remainder having double rows. The steam from this turbine is passed into the low pressure ahead turbine in which there are 11 expansion stages, and from there into an underslung condenser, which is bolted direct to the exhaust branch of the turbine ; the condensate, it is interesting to note, is dealt with on the Weir closed feed system, which will be described in detail later on. The rotary pump for dealing with the condensate, forming part of the vacuum unit, is shown on page 288 Astern turbines are incorporated in the casings of the intermediate and low pressure ahead turbines.

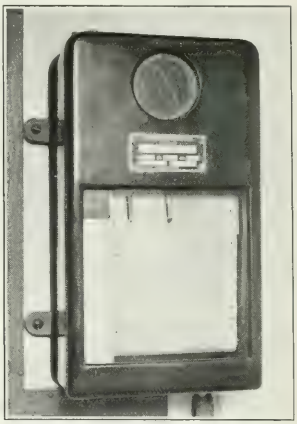
Gears.—The propellers are driven through double reduction gearing, and this is of the double helical type ; we publish three views of various units of the gearing on pages 288 and 292. The first reduction pinions have internal spindles through them, being bored throughout their length. The forward end of the spindles is driven through a flexible claw coupling, and the after end conveys the drive to the pinion through a flanged coupling. All the gearing, journal bearings for the turbines, and the thrust blocks work under forced lubrication, and this system is maintained by three direct-acting pumps, which draw oil from a drain tank situated underneath the gear cases, and deliver it through the usual strainers and coolers. The bearings and thrust blocks are lubricated by means of oil supplied from a gravity tank, arranged in the engine room



The Sperry Master Compass.

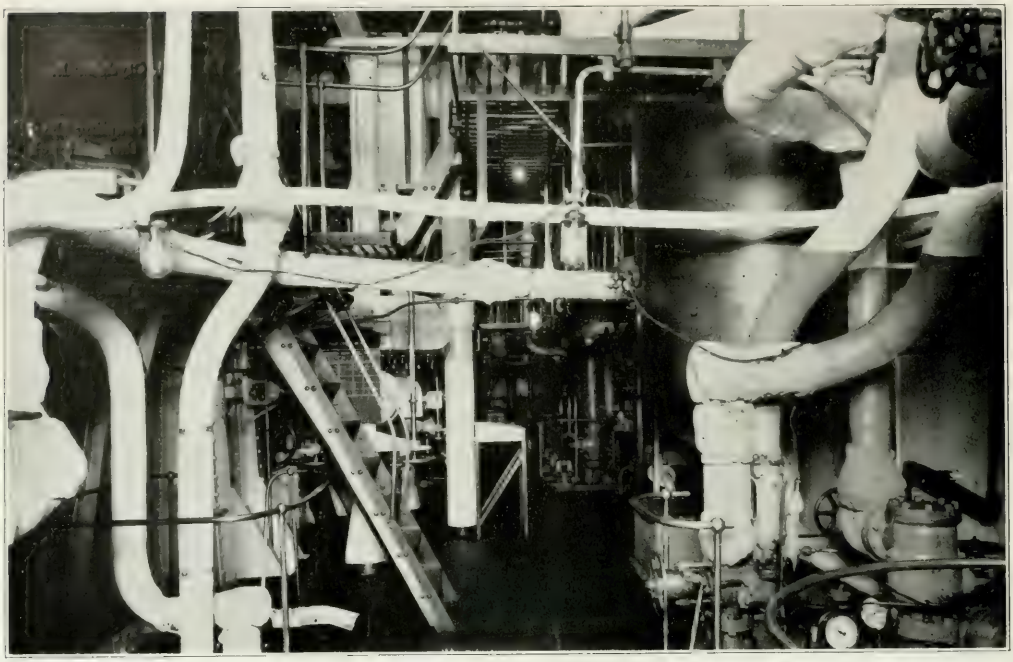


Pneumercator Gauges in the Boiler Room.

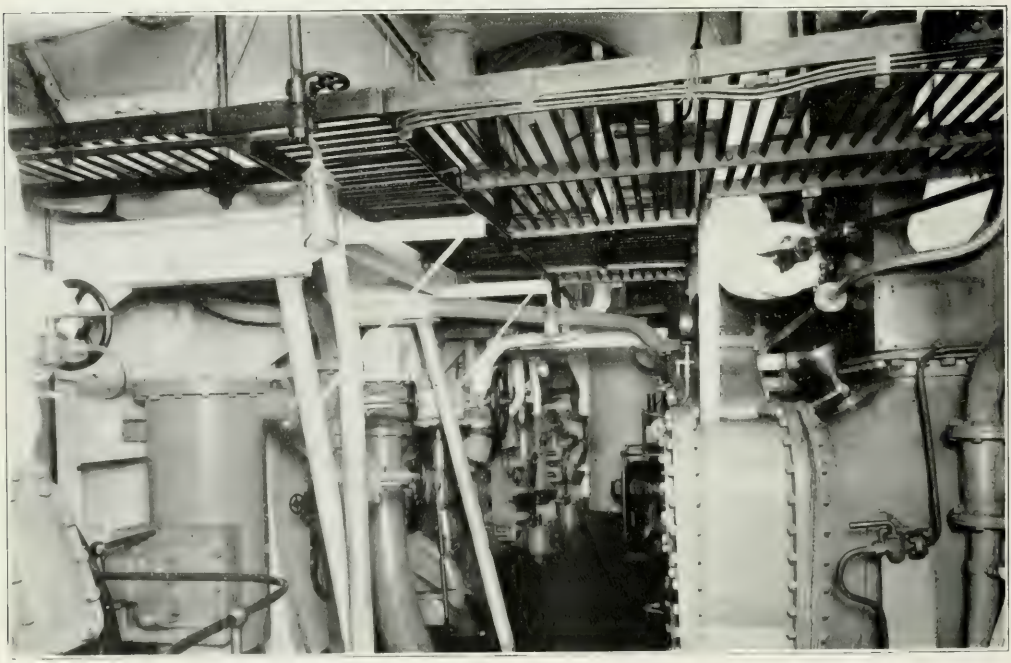


The Sperry Course Recorder.

THE MACHINERY SPACE OF THE

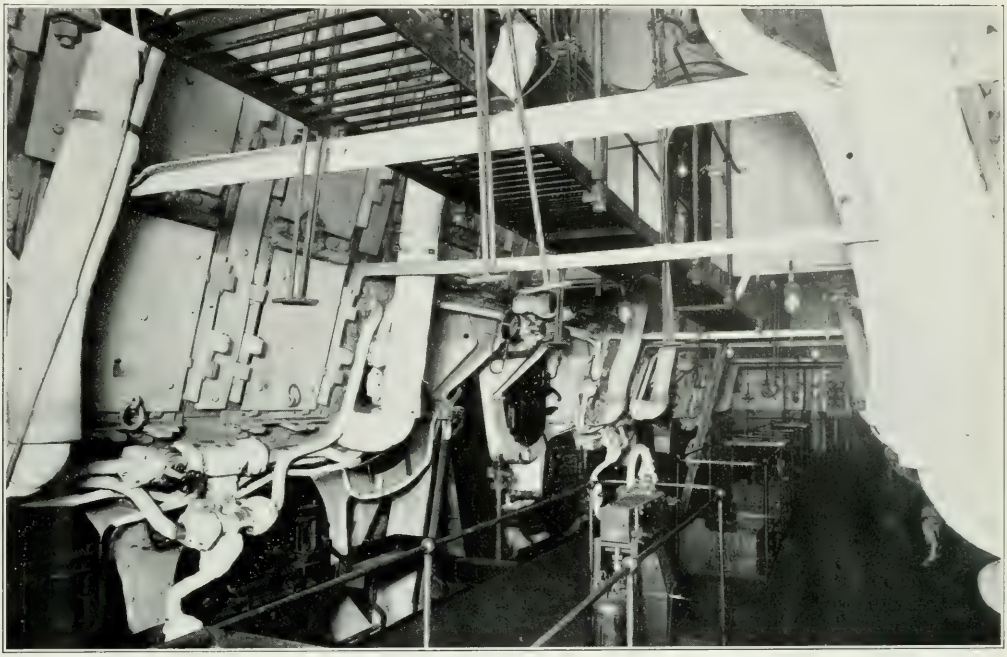


A View of the "Franconia's" Engine Room, showing Control Position and Watch Desk.

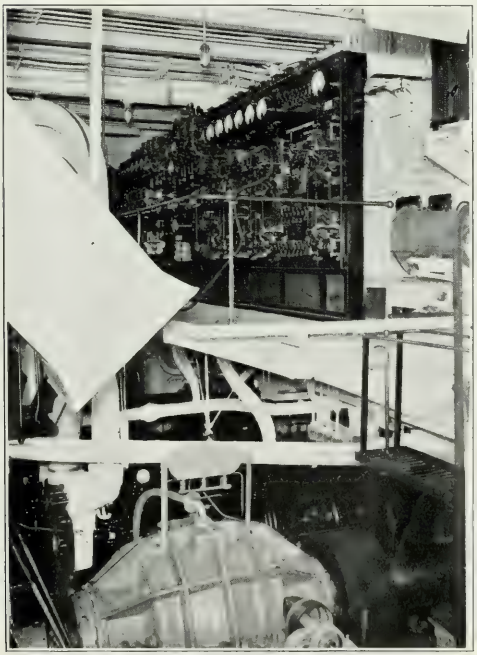


View looking along the Starboard Side of the Engine Room.

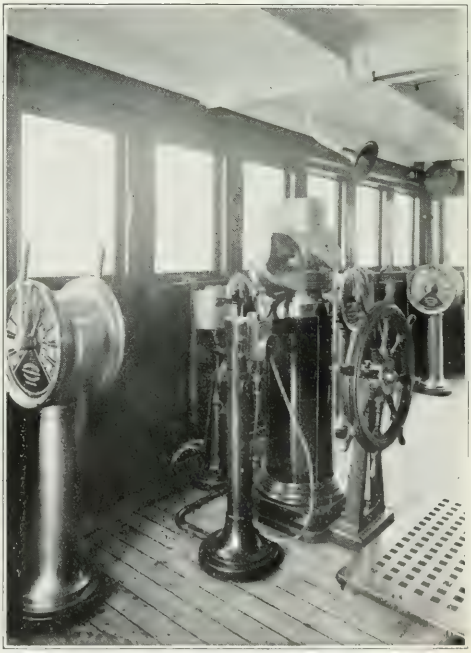
CUNARD LINER "FRANCONIA."



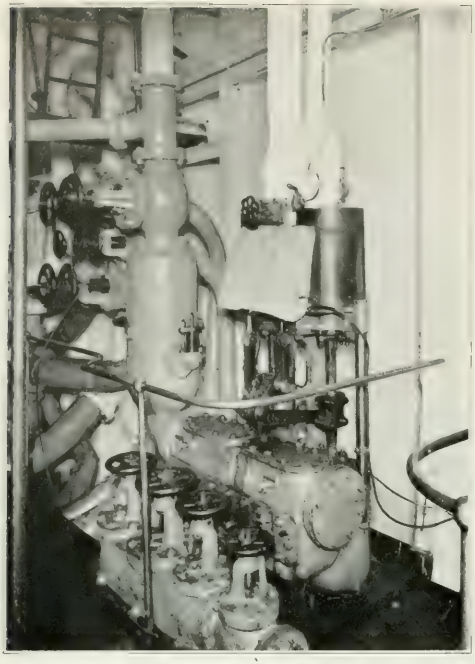
A General View of the Centre Stokehold, showing the Wallsend-Howden Oil Fuel Burning System.



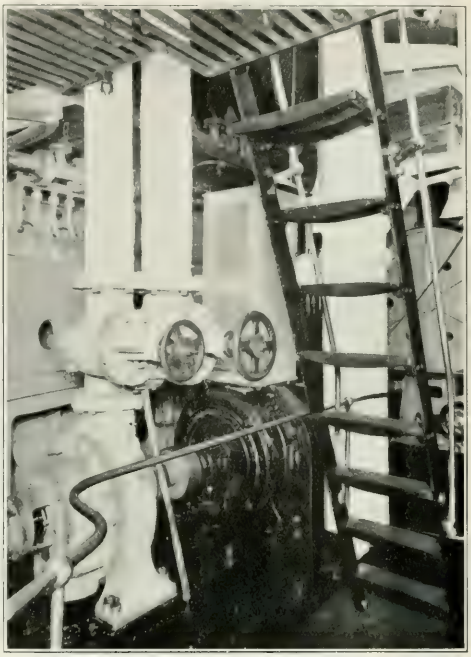
The Michell Patent Thrust on the Starboard Side.



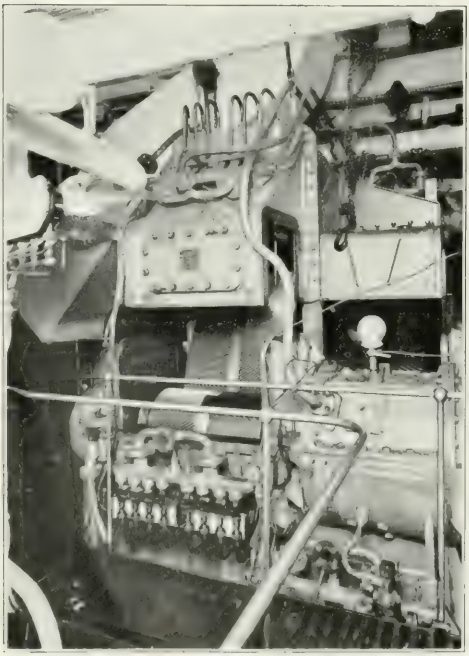
The Steering Position on the Navigating Bridge, showing Robinson Telegraphs and Sperry Gyro Repeater.



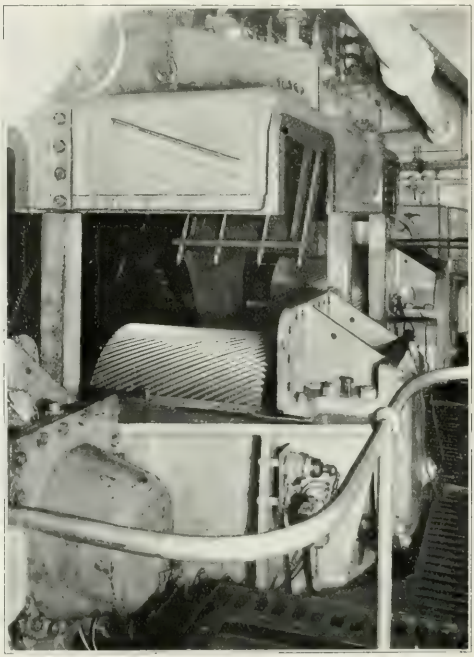
Fire and Bilge Pump of Cunard Co.'s Make.



Rees Turbo-driven Rotary Sanitary Pump.

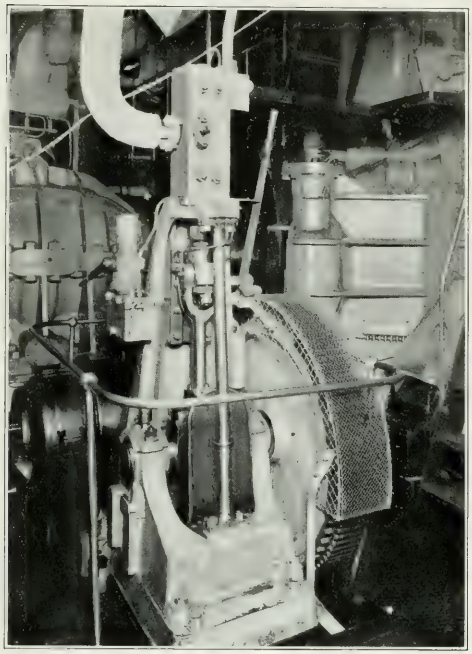


The Primary and Secondary Pinions and Gear Wheels for the Starboard Turbines.

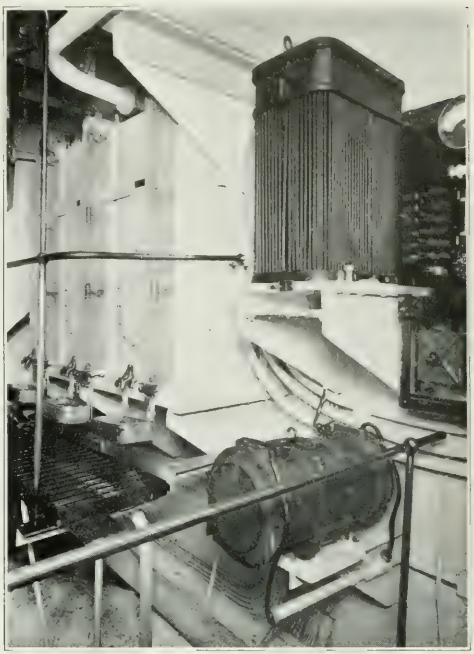


View of Gears from the Centre Line of Ship.

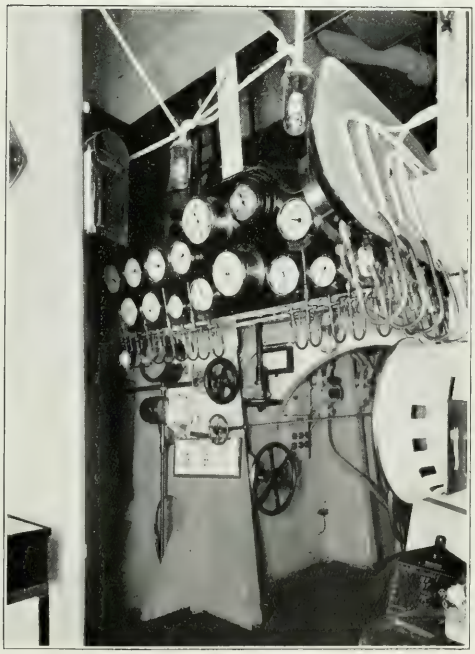
CUNARD LINER "FRANCONIA."



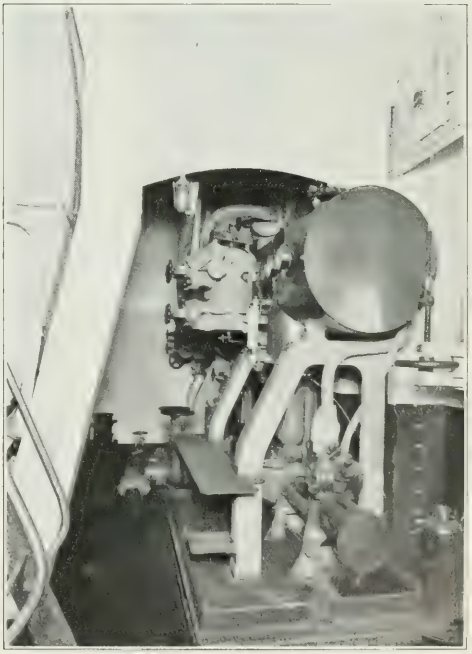
Motor-driven Vertical Refrigerator for Ship's Stores.



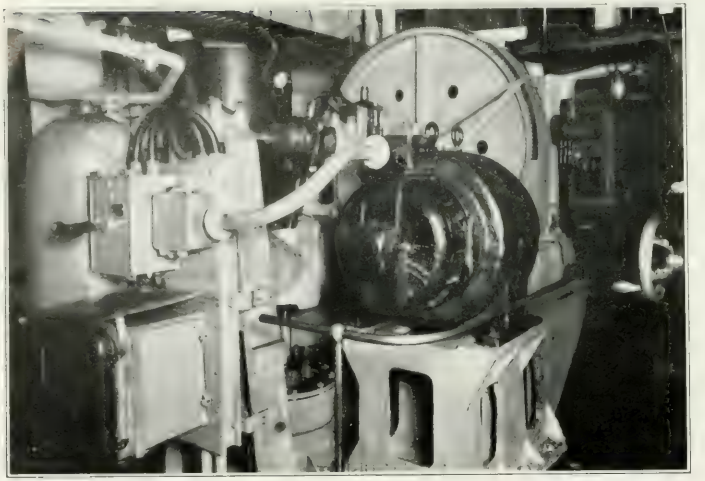
The Rotary Transformer for the Cumberland Electrolytic System.



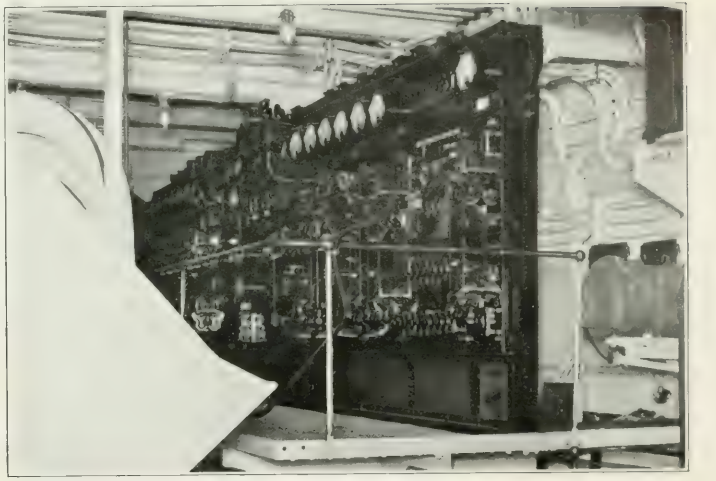
Control Position, showing Gauges, Barometer, Clocks, etc.



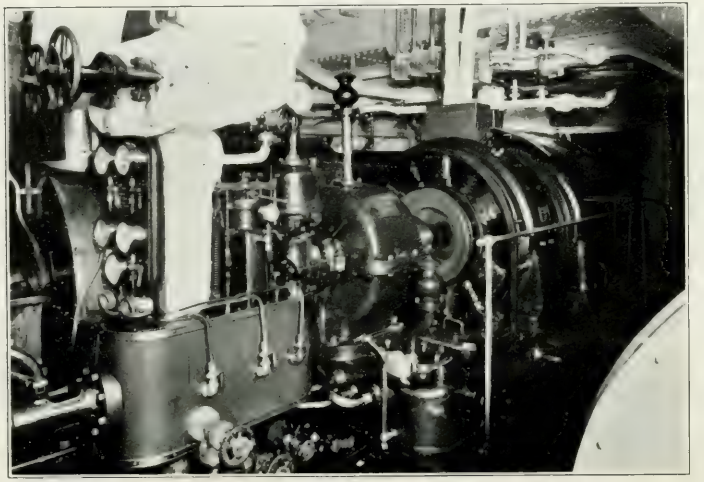
The Aft Starboard Wallsend-Howden Oil Fuel Unit.



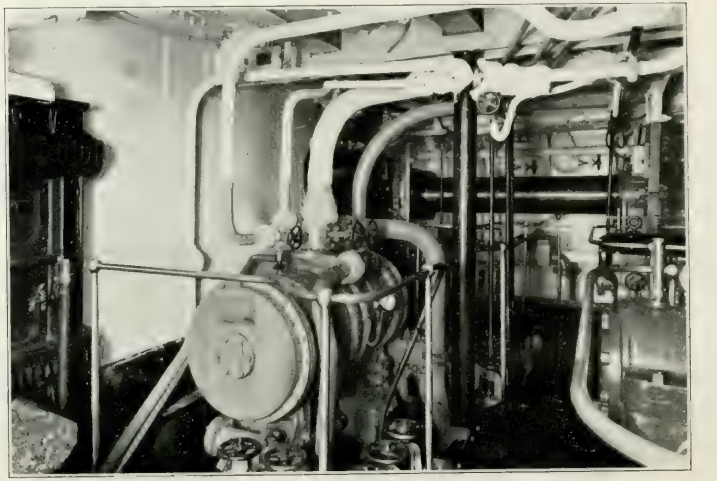
Carruthers Type Motor-driven Ballast Pump.



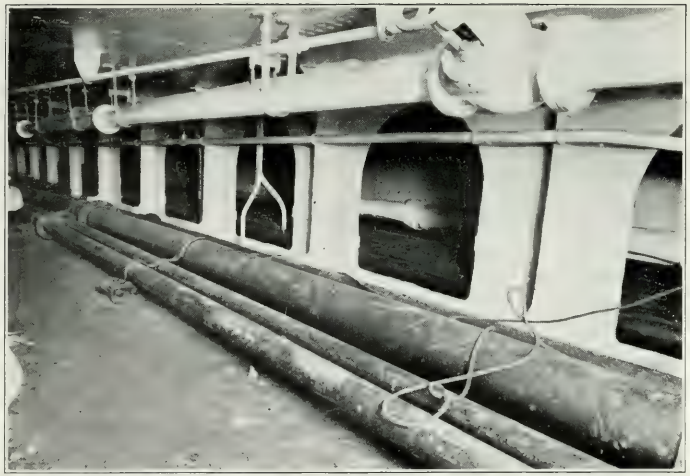
The Main Switchboard. View from Port Side.



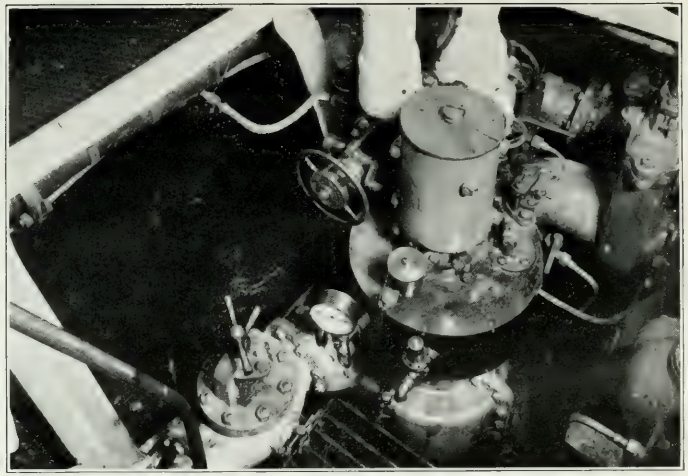
The Port Turbo-Generator, showing Gearing, etc.



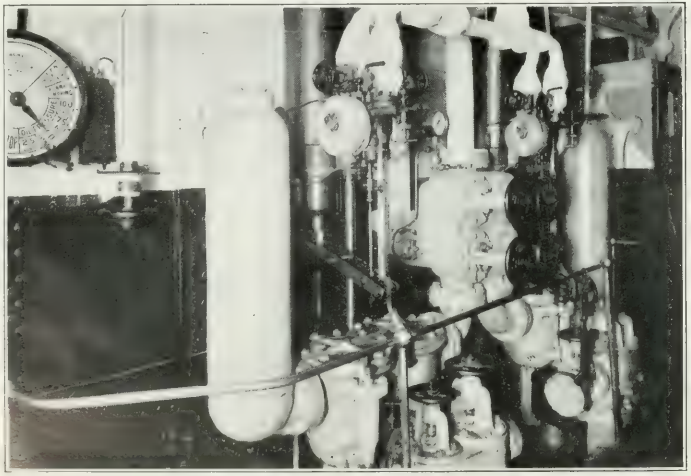
The Drain Condenser at the Aft End of the Engine Room.



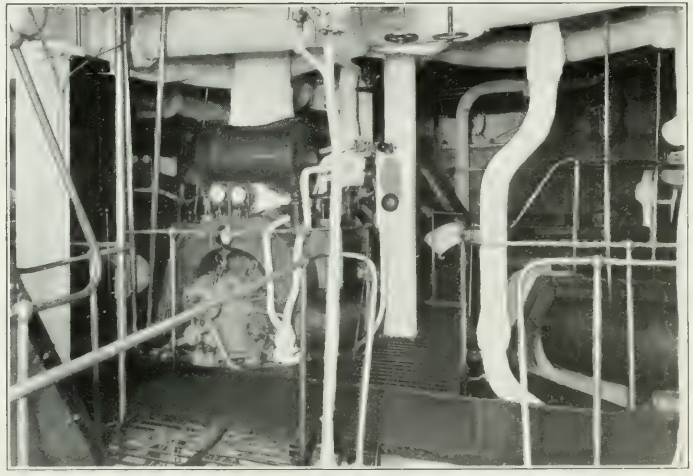
View under the Swimming Bath, showing Bilge, Ballast and O.F. Filling Pipes.



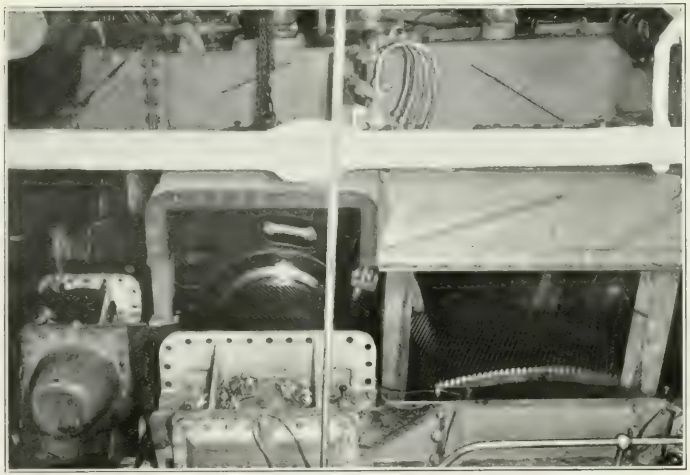
The Weir Closed Feed System. The Starboard Rotary Pump for the Condensate.



The Oil Fuel Transfer Pumps in the passage between the Engine and Boiler Room.

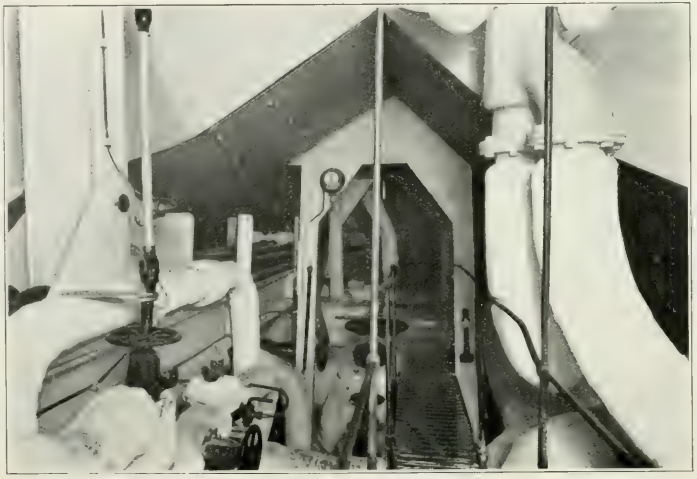


The Aft End of the Port H.P. Turbine, showing the Steam Filter.

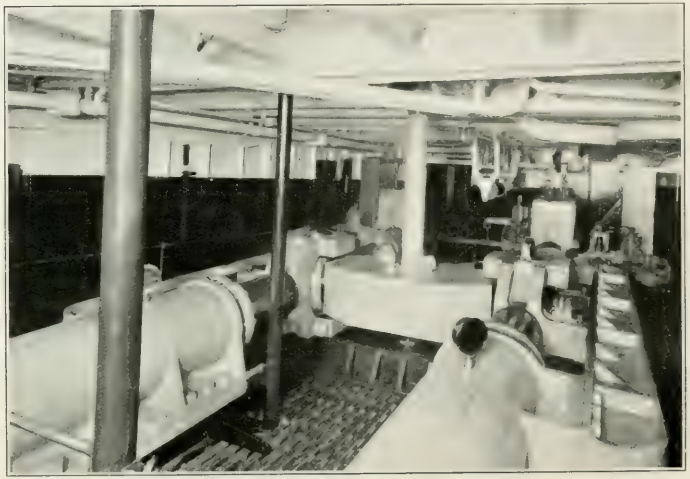


View looking from Switchboard Platform, showing Main and Secondary Gear Wheels.

The Main Turbo-Circulating Pump, showing its Valve Controls.



View looking across Boiler Tops, showing Main Stop Valves, etc.



The Electric-Hydraulic Steering Gear.

hatch, and taking the discharge from one of the coolers. The discharge from the other two coolers passes to another gravity tank from which oil is supplied to sprayers for the gearing teeth. The gravity tanks, however, can be by-passed if necessary and the oil can be delivered direct to the bearings and sprayers. There is a de Laval unit for purifying the oil, working on the centrifugal principle.

Auxiliary Machinery.

Condensing plant and feed system.—The condenser has been mentioned already. The main circulating pumps, one of which we illustrate on page 292, is of the turbine-driven type, supplied by G. & J. Weir Limited; it supplies also water for the oil coolers and for the air ejector condenser of the Weir closed feed system. The latter may now be described in more detail.

The system is fitted to both main and auxiliary condensing units, so that whether the ship is at sea or in port the feed water as delivered to the boilers is entirely free from air. In the main feed system the condensate is withdrawn from the main condensers by two Weir turbine-driven water extraction pumps and delivered under pressure through the feed suction range to the feed pump suction. One Weir turbine-driven and two Weir direct-acting boiler feed pumps are fitted, the former being the main unit while the latter act as standbys and are also used for port duty. Two Weir air ejectors are fitted to each main condenser, the main air ejector being of the inter-condenser type and the standby ejector being of the simple type. These ejectors discharge to a Weir heater condenser through which the water extraction pumps discharge so that the heat in the ejectors' exhaust is conserved in the feed water. Weir supplementary feed and overflow valves with float control box are fitted so as to render the feed system automatic in operation. The Weir turbine-driven boiler feed pump is operated on the discharge side by a dashpot discharge valve controlled by a float in the feed tank, while the standby Weir direct-acting boiler feed pumps are steam controlled by the same float in the feed tank.

A Weir multiflow surface feed water heater is fitted on the discharge side of the boiler feed pumps; this heater receives all the exhaust steam from the engine room steam-driven auxiliaries. The drain from this heater passes to the condenser portion of the Weir heater condenser and flows through a sponge filter in the feed tank. By this arrangement the greasy drain from the heater is first cooled and then filtered. It is not therefore necessary to filter the whole body of the feed water.

For port working, the Weir direct-acting boiler feed pumps draw the condensate from the auxiliary condenser through a Weir sponge filter and float tank. The float in this tank controls the steam to the Weir direct-acting feed pumps, so that these pumps give no trouble through hammering as their speed is always such that there is sufficient head over the suction valves. A vacuum of 20 in. is maintained in the auxiliary condenser by a small Weir air ejector and ejector condenser. The Weir direct-acting feed pumps discharge through a small Weir multiflow surface feed water heater, and the drain from this heater is led to the auxiliary condenser so that all the feed water is cooled and filtered before passing to the feed pump.

The circulating pump for the auxiliary condenser is driven by a vertical enclosed single cylinder engine, and was supplied by Matthew Paul & Co., Dumbarton. There is a 250-ton motor-driven ballast pump situated on the port side of the engine room; the pump being of the Carruthers type, whilst the motor was supplied by Electromotors Limited. It is a shunt-wound machine taking current at 220 volts, which incidentally is the standard voltage for the ship's power circuit, and running at 750 revolutions. There is also a ballast pump of the vertical duplex type with gunmetal water ends, supplied by J. H. Carruthers & Co. Ltd., who also supplied the drain condenser, illustrated elsewhere, and its necessary pumps. The sanitary pump, which takes water from the sea and discharges it through the sanitary and service mains, is of the Rees Roturbo type, and it is driven by a motor of the Rees Roturbo type. The motor ballast pump is illustrated on page 290. There is a direct-acting fire and bilge pump of the Cunard Company's own make, also on the port side of the engine room, and this is illustrated on page 288. There are two 50-ton sets of vertical evaporators of Weir's make having automatic feeding systems and brine ejectors. The sets may be worked singly or in series; the distiller can deal with 50 tons of water per 24 hours.

There are two distinct sets of refrigerating plant. That for the cargo is supplied by the Liverpool Refrigerating Company, and is situated in a compartment between the shaft tunnels. That for the ship's stores situated in the main engine room consists of a vertical motor-driven machine, which we illustrate on page 289, the motor being supplied by W. H. Allen, Sons & Co., Bedford, rated at 21 b.h.p.

Generators.—There are two turbo-generators, supplied by the Metropolitan-Vickers Electrical Company Limited, situated at the aft end of the engine room; we illustrate the port unit on page 290. Each unit consists of a turbine of the Rateau type, running at 4,500 r.p.m. and developing 500 b.h.p., which drives through a 4·5 to 1 reduction gear a generator giving 220 volts D.C. The main switchboard, illustrated on page 290, and also the eleven auxiliary feeder switchboards situated in different compartments about the ships, were supplied by Whipp & Bourne Ltd., Castleton, Manchester. The generator main circuit breakers are arranged for hand or electrical operation, and the supply to the various parts of the ship is arranged on the three-wire system.

Boilers.—There are three single-ended and three double-ended boilers, each having a diameter of 17 ft. 6 in., the lengths being 11 ft. 6 in. and 22 ft. 6 in. respectively. The furnaces are of the Morrison type, each having separate combustion chambers; in the smaller boilers there are four furnaces and in the larger eight; Diamond blowers are fitted for tube cleaning. The boilers are fitted for burning oil on the Wallsend-Howden system, and the plant comprises two large and two small units of which one large and one small unit are capable of supplying all requirements at full power. We illustrate the aft starboard unit on page 289, and on page 285 will be found two of the pneumercator gauges supplied by Kelvin Bottomley & Baird Limited. The oil fuel transfer pumps are of Weir's make; there are two situated in the passage between the engine room and the boiler rooms, and either of them may be used to draw waste oil from the bilges. For the prevention of corrosion in the boilers the Cumberland electrolytic system is fitted, and we illustrate the rotary transformer for this on page 289. The latter is a shunt-wound machine supplied by the Submersible Motors Limited, Southall, Middlesex.

On page 291 will be found a view of the steering gear, which is of the Williams Janney electric hydraulic type, supplied by Brown Bros. Ltd., Edinburgh; the motors have been supplied by Bruce Peebles & Co. Limited.

The Sperigyro Compass Equipment.

This consists of a small motor generator, storage battery, control panel, alarm unit, and master compass, contained in the compass room situated on "E" deck, and two repeater compasses, and an automatic course recorder located on the bridge and in the chart room respectively. The motor generator is a combination of a D.C. motor (100 volts), an A.C. generator (45 volts) and a D.C. generator (20 volts). The ship's supply provides the 100 volts to drive the motor, the A.C. current is utilised for driving the compass rotor, and the D.C. winding furnishes the current for the azimuth motor, the repeater system and the storage battery. In case of failure of the ship's supply, the motor generator is cut out from the

supply line by an automatic circuit breaker. The low voltage current from the battery then operates the motor generator until such time as the supply is again forthcoming. The control panel controls the operation of the gyro compass system, and it is equipped with suitable meters and switches for the master and repeater compasses, and also with a circuit breaker. In the event of the failure of the ship's supply, the operation of the compass remains uninterrupted, as the battery supplies the necessary current. In order that the officer of the watch may be notified of this failure, and also to protect the battery from exhaustion, an alarm bell on the bridge, and buzzer in the compass room, are operated automatically by the closing of two contacts when the circuit breaker opens, due to the demagnetisation of its coils when the supply fails or when there is a material drop in the line voltage.

The master compass illustrated on page 285 is supplied with a rugged transmitter of the commutator type, which passes the indications of the master to the repeaters and course recorder. The gyroscopical element consists fundamentally of an electrically-driven wheel, mounted so as to form a gyroscope with three degrees of freedom. The gyro wheel constitutes the rotor of a three-phase induction motor, and is a high-grade bronze flywheel, 10 in. in diam. and 55 lb. in weight, driven at a speed of 5,500 r.p.m. The stator of the motor is rigidly secured to the inside of the case containing the rotor, its shaft and bearings. The gyro element is of the non-pendulous type, and the precessional movement is controlled by the flow of mercury from one side to the other. This piece of apparatus is known as the mercury ballistic.

One repeater compass is situated in the wheel house, and is used as a steering compass; it is illustrated on page 287. The other is mounted on the conning platform, and is supplied with an azimuth mirror for taking celestial and terrestrial bearings. The automatic course recorder situated in the chart room enables full value to be obtained from the Sperigyro installation, and this unit of the equipment comprises a repeater compass motor and clock-like mechanism. By its use the time, and every movement of the ship's head, is recorded on paper, and thus becomes a permanent record, facilitating dead reckoning calculation. The fitting of this recorder enables the navigator to observe the vastly improved steering that is found by use of the Sperigyro compass due to its directive force being some 30 times greater than the best magnetic compass. It also keeps a check on the quartermasters, and should promote competitive steering with consequent economical results.

THE RECONDITIONED PASSENGER LINER "LEVIATHAN."

Some Notes on her Main and Auxiliary Propelling Machinery.

Southampton was able to number amongst its quota of mammoth passenger liners yet another vessel, when the ex-German *Vaterland*, now the U.S. liner *Leviathan*, was berthed in the Ocean Dock on Tuesday, July 10. The vessel, it will be recalled, has had a somewhat chequered carreer. Laid down at the Hamburg yard of Blohm & Voss, she was launched on April 3, 1913, and called at Southampton on her maiden voyage on May 15, 1914. She was in New York on the outbreak of war and was interned there until 1917, when she was seized by the United States Government and used as a transport; actually, she made only three voyages across the Atlantic under the German flag. The reconditioning of the *Leviathan*, which was carried out by the Newport News Shipbuilding & Dry Dock Company, has cost approximately $8,200,000, and the work has been carried out under the supervision of Mr. William H. Gibbs for the United States Shipping Board.

The principal dimensions and particulars of the vessel under her latest measurements are as follows:—

Length, overall	949 ft. 9 in.
,, b.p.	928 ft. 5 in.
Breadth, moulded	100 ft.
Depth, moulded to "D" deck	70 ft. 4½ in.
Draught, load	40 ft.
Displacement	66,800 tons.
G.R.T.	56,940 tons (app.).
N.R.T.	28,000 tons (app.).

The main propelling machinery has been thoroughly overhauled and reconditioned. It comprises a four-shaft arrangement, each shaft being driven by direct-coupled Parsons turbines. The port and starboard inboard shafts are coupled respectively to a high pressure and an intermediate pressure ahead turbine. Both of these shafts have also high pressure astern turbines. Each of the outboard shafts has a low pressure ahead and a low pressure astern turbine. When the ship is running steadily at sea, steam is put through the high pressure ahead turbine, then through the intermediate pressure turbine from which it exhausts into the low pressure turbines; for manœuvring purposes, however, steam comes from the boiler direct to the high and intermediate pressure turbines and thence to each of the low pressure turbines.

There are 46 boilers of a modified Yarrow type, which generate steam for a working pressure of 248 lb. per sq. in.; they are arranged in four boiler rooms, and during the reconditioning they have been fitted to burn oil. Five oil burners of the Peabody type are fitted to each boiler, but the original coal-burning equipment has been retained should it prove necessary at any time to reconvert the vessel to burn coal. The total oil fuel capacity is about 9,563 tons, and storage for this has been arranged as follows: There are eight service tanks, 13 deep tanks, and 25 double bottom tanks. The latter are all forward of the fore end of No. 4 boiler room, where a cofferdam has been built to cut them off from the fresh water tanks arranged aft of this. The service tanks are arranged in what were formerly side coal bunkers, and there is one on each side of all boiler rooms except No. 4, which has a cofferdam built up above the tank top to cut off the service tanks from the fresh water in the double bottom tanks below; there are in all, 50 Pneumercator gauges connected to the tanks. A donkey boiler in No. 4 boiler room is an additional fitting, and this has been fitted to supply steam to the service pumps situated in No. 4 boiler room and to the manifold which controls steam for the oil-heating coils in the service tanks.

The steam-heating system throughout the ship has been renewed, and this has been tested to withstand the full boiler pressure which obviates any damage to passengers should the reducing system through some mishap (pressure is actually reduced to 30 lb. per sq. in.) fail in operation.

Electric current for the ship's lighting and for driving motors is supplied by the original four 288-kw. turbo-generating sets supplied when the ship was built. There is also a new 500-kw. set supplied by the General Electric Company, Schenectady, N.Y. There are also two entirely separate emergency generating sets situated aft on "E" deck; these consist of two 60-kw. generators direct connected to Worthington-Diesel engines.

SOME OIL ENGINE EXPERIMENTS.*

A Resumé of some interesting Trials carried out on a Scott-Still Engine.

By A. I. NICHOLSON, B.Sc.

The success of any engine being dependent upon the solution of the numerous problems in its design and construction, the purpose of this article is to record some experimental results upon certain details met with in oil engine design, in the hope that they may help to illuminate some of the more elusive elements. The experiments which form the subject of the article were carried out on a combined oil and steam engine, but they have been specially selected and presented with a view to their being of value and interest to oil engine designers and users in general. The engine referred to was an engine working on the Still principles, and known as the Scott-Still engine. It was designed, constructed and tested by Scotts' Shipbuilding and Engineering Company, Greenock.

The engine, with all its necessary fittings, pipes and auxiliaries, was erected on the test bed, and the power was absorbed and measured by a Froude dynamometer manufactured by Heenan & Froude. This dynamometer was found to be a very satisfactory instrument.

The fuel was measured by drawing it from graduated tanks. Two were provided, one being in use at a time. The calibration of these tanks was checked more than once to ensure accuracy. A method of weighing the fuel oil was tried, but the readings obtained did not appreciably vary from those obtained from the calibrated tanks. The drawback to calibrated tanks is that allowance must be made for the temperature of the oil in the tank and for its specific gravity. On the other hand, calibrated tanks are easy to manipulate.

A variety of indicators were used at different times, including a Hopkinson flash-light indicator. The indicator gear fitted was of the lever reduction type, designed to give a mathematically correct reduction. Ground case-hardened pins and bushes were used throughout, and a heavy spring was applied to the end of the lever to eliminate any reversal of load upon the bearings.

Mechanical Efficiency and Engine Friction.

The power absorbed by any machine in simply driving it round is a very important factor in fixing the efficiency of the machine. No matter what the power developed by the machine may be, the effective power output is what remains after deducting the frictional horse-power. In reciprocating engines where there is a considerable number of rubbing surfaces the loss from friction is considerable, and in oil engines where the piston surfaces play a large part in causing the losses the mechanical efficiency is lower than in steam engines. The losses can be fairly readily determined from reciprocating engines when the brake horse-power is known, for the indicated power can also be determined.

It appeared from a number of results on the engine under consideration that the frictional torque, or the friction expressed in terms of a pressure per square inch of piston area, changed slightly with the revolutions, and it did not appear to change much with the load on the engine. It seems very probable that the same will hold for all oil engines when auxiliaries such as air compressors and scavenging blowers are excluded. This is, therefore, a very convenient figure to determine for any engine, since from it, the horse-power absorbed in overcoming the mechanical friction of the engine at any speed can be determined.

In the case of the experimental Scott-Still engine, there were two ways available to determine the frictional mean pressure, namely, by running the engine light on steam only, or by comparing the brake power with the indicated power.

The figure so obtained represents the power absorbed in the main engine bearings and piston, in the auxiliary engine bearings and piston, and in all the pumps driven by the engine, namely, regenerating circulating pump, and fuel injection pump for the oil side; the air pump, feed pump, and high-pressure valve gear pump required for the steam side; and in the windage of the flywheel. The existence, therefore, of these extras about the engines lowers its mechanical efficiency, but the effects of all of these are included in the figures following. A third method was also adopted as a check upon the others. The engine was put up to full speed, then every source of external power was shut off, and counter readings taken every few seconds. From these results, knowing the moments of inertia of the rotating portions of the engine, it is possible to deduce the engine friction. Steam cards gave a frictional mean pressure of about 10 lb. per sq. in. of piston area calculated as acting during the combustion stroke. That is, if the indicated mean pressure were 90 lb. per sq. in., the brake mean pressure would be 80 lb. However, as an average from a great many readings, the engine friction with the engine on load was found to vary from 8 lb. at 70 r.p.m. to 11 lb. at 130 r.p.m.

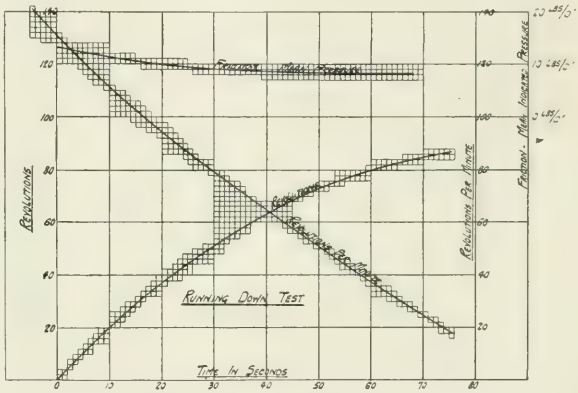


Fig. 1.—Curves showing results of Running-Down Test.

Running-Down Test.—In Fig. 1 is plotted one set of readings from a stored energy or running-down test carried out under the conditions previously referred to. From this, by graphical differentiation, a revolutions-per-minute curve has been obtained, and from the relationship that torque $= \frac{I \times \ddot{\omega}}{g}$ where I = moment of inertia of the rotating weights of the engine in lb. × ft.², and $\ddot{\omega}$ = angular retardation in radians per second², it is possible to determine the frictional mean

* Abstract of paper read before the Institution of Engineers and Shipbuilders in Scotland.

pressure in lb. per square inch of piston area over the range of the test. The friction curve so deducted is also given. It will be seen that this gives values varying from 13 to 8·25 lb. Great accuracy cannot be obtained in the ordinary course in a test of this kind, for the revolutions read from the counter are to the nearest whole number only. The results are, however, reasonably in agreement with the figures deduced from indicator cards.

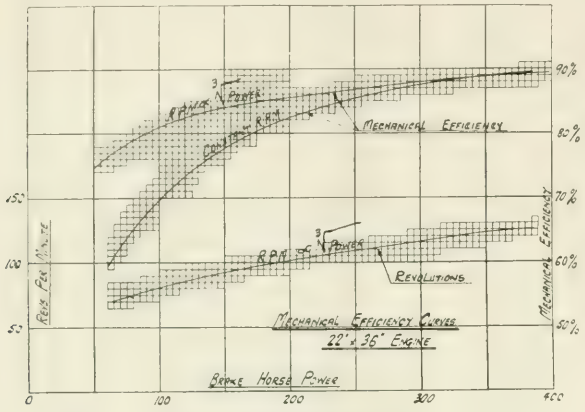


Fig. 2.—Curves of Mechanical Efficiency to a base of B.H.P. for Different R.P.M.

Mechanical efficiency curves have been plotted in Fig. 2 above for :—

(1) Constant revolutions (as for electric generating engines). In this case the revolutions per minute equal 120.

(2) Revolutions varying as the cube root of the power, *i.e.*, approximately in accordance with the variation of revolutions and power on board ship.

These curves have been constructed on the basis of frictional mean pressure given above. It will be seen how quickly the mechanical efficiency falls off at low powers when the revolutions are kept constant. This suggests that electrical engineers might well consider if generators could not be regulated in some other way than by maintaining constant speed at all loads.

Fuel Injection Experiments.

Airless fuel injection was the system in use, that is, the oil was injected under pressure and not blown in by air. One fuel pump was used for the cylinder, so arranged that it discharged only during the injection period. The pump was driven by a cam on or connected directly to the crankshaft. The fuel valve was of automatic type, opening whenever the oil pressure reached a certain predetermined amount and closing whenever the pressure fell to a definite amount. The pump was of ample capacity to discharge from two to three times the amount of oil necessary, and a combined relief and spill valve was fitted in the oil discharge system, so that any desired amount of oil might be allowed into the combustion cylinder, the remainder being automatically relieved by the valve opening under pressure, and/or finally spilled from the system by the valve being positively lifted off its seat. Given a certain form of cam and a fixed size of pump plunger, the rate of pumping was fixed when the revolutions per minute were fixed. The rate of injection of the fuel into the cylinder depended upon the rate of pumping, but was not necessarily equal to the pumping rate, because of the existence of the relief valve on the system. In reality the rate of injection depended upon the area of the oil fuel spray holes and the mean oil pressure maintained at these holes, and the period over which it was maintained. The determination of the oil pressure in the system was very difficult, for the whole injection process occupied only about 1/25 second, and the rise in pressure from zero to about 6,000 lb. per sq. in. took place in about 1/140 second. Attempts were made to find out the maximum pressure of injection, and readings were secured, but one would not care to guarantee their accuracy.

A little consideration of the features inherent in the system of injection under which the following experiments were carried out, will show that in some respects the system is not a very suitable one for experiment, as it is almost impossible to change one variable at a time, since the variables are all more or less interdependent. The results following should, therefore, be considered in the light of the above explanatory remarks regarding the system of injection. For instance, every change made, as, for example, in the size of spray holes, had some small effect on the period of injection and the pressure at which the injection of the oil took place. Slight changes in these factors were found to have little effect upon the combustion, and thus may reasonably be neglected. It may be useful, in forming some idea of the injection process, to consider how much fuel oil was pumped into the engine cylinder during each stroke when at full power. Taking about 120 lb. of oil per hour, the equivalent volume of oil injected each revolution amounted to ·5 cub. in., or the equivalent of a spherical ball 1 inch in diameter. If this were injected through eight holes of 24 thousandths of an inch diameter, the equivalent jet length for each one is about 11½ feet. The usual period during which the fuel valve was open was about 20 degrees of crank angle, and the full open period was about 13 degrees, or, say, ·018 second at 120 r.p.m.

(*a*) Atomisation of the Fuel.—The first jets tried had spray holes of 20 mm. diameter, and for some time after the tests began no other means of atomisation than by small holes and high pressures were considered. The results, however, that were obtained in the first set of trials were not very promising, and new means of atomisation were considered.

(i) *Vortex or "Whirling" Sprayer.*—Boiler oil-fuel burners were known to atomise the oil under very low pressures, and the principle on which these worked was to "whirl" the oil. It was not expected that with the spasmodic discharge of the engine very good atomisation would occur with such a jet, but on trying a spray orifice having part of a helical groove cut in it, excellent results were obtained in the open. It had become customary to test all sprayers in the open before trying them in the engine, and the tests with a plain hole sprayer showed that the jets were atomised finely at the circumference, but had a core of unatomised oil. A candle held in way of the sprays might be extinguished, and very seldom would set the oil alight. A torch would set it alight, but the combusion was rather leisurely. On the other hand, a vortex or "whirling" sprayer gave an exceedingly fine cloud of oil, which floated up into the atmosphere above the valve. A candle held in this spray set the whole off quite violently. The atomisation obtained was far ahead of what was obtained with the plain hole sprayer, and was practically perfect. It was, moreover, obtained with a relatively large passage through the cap, and this alone was a feature of considerable value, for it meant that the chances of a stoppage, due to particles of dirt lodging in it, were negligible compared with the chances where holes of 20 or 25 mm. are used. It may be mentioned that it was the rarest thing, after the first few runs and the adoption of proper precautions, to have any sprayer holes clogged or stopped. When tried on the engine the results given by this "whirling" sprayer were poor and disappointing, for high

loads could not be carried, though at low powers the results were quite good.

(ii) *Ejector Sprayer.*—A further device tried was what may be termed an ejector sprayer. Atomisation requires energy to produce it. It was thought that it might be possible to get an additional source of energy by starting combustion of the oil within the sprayer. An ejector can be made to draw in from the surrounding space, and by fitting a combining tube with an expanding nozzle it is possible to deliver against a moderate back pressure. It was thought that by making a jet of oil draw in hot air from the cylinder combusion might start in the combining tube and the energy therefrom would assist in discharging the jet from the nozzle, and give both better atomisation and better distribution of the fuel in the combustion space. Two such sprayers were made, the result being a very fine bit of workmanship. In the open they sprayed very much like plain hole sprays, but it was impossible to know if they were functioning as ejectors. In the engine their behaviour was not in any way distinguished from plain hole spray orifices. It was noticed that the air inlet holes were quite clean after use, indicating that at least no oil was being discharged there, and suggesting that they were probably drawing in a little air.

The results, however, were not promising enough to warrant further experiment.

(iii) *Small Hole Sprayer.*—A very fine hole sprayer was made and tried to determine further the benefit of extreme atomisation. In addition, this spray had a large number of holes. The results were very much the same as the better of the whirling sprayers. Fig. 3 shows the results of these several sprayers.

(*b*) Penetration—Varying Sizes of Sprayer Holes.—The oil which is injected into the cylinder must, in the first place, be atomised to some extent to facilitate combustion. It must also be well thrown into the air space to reach the air available. It is essential that as much of the air in the cylinder

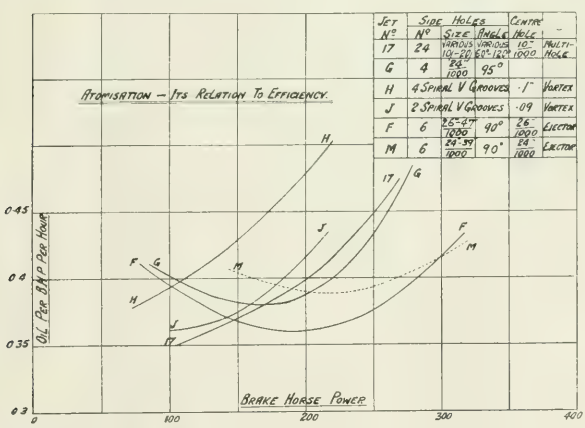


Fig. 3.—Curves showing the Relation of Atomisation to Efficiency.

as possible be "interested" in the oil, for there is no time for any leisurely process of combustion to take place. Unless there is turbulence in the combustion space the air will not come to the oil, so the oil must go to the air, that is, the oil jets must penetrate well into the furthest recesses of the combustion space. The ability of a jet to penetrate through air at a pressure of 300 lb. per sq. in., and about eight times as dense as the atmosphere, depends upon high speed, bulk, and compactness.

High speeds call for high pressures, and high speeds are favourable to atomisation. A large diameter jet travels further than a small diameter one, but is more difficult to atomise completely. A jet that is breaking up or atomising is not a good "projectile"; a non-atomising jet goes further. Atomisation and penetration are directly opposed, and the practical question, therefore, is: Which is the more essential for good combustion? In the preceding section it has been seen that extreme atomisation alone is of no value. At 210 b.h.p. there is little to choose between the results of these, but as the load increases it will be seen that the 24 mm. jets have the advantage. Even at light loads they show up better. This latter is hardly what would be expected. At 300 b.h.p. and over the failure of the small jets to get at the air in the cylinder is evident. More surprising, perhaps, is the importance of what seems a very small difference, namely, 20 to 24 mm. The area of a 24 mm. hole is, however, 44 per cent. larger than a 20 mm. hole, a difference which is quite substantial.

When considering these results it may be noted that an increase of area of holes such as this changes the pressure of injection, but this appears to have very little affect upon the consumption rate, and consequently the results on this figure are fairly comparable.

(*c*) Distribution of Fuel in the Air Charge.—The effect of the penetrative power of the fuel jets has been discussed in the preceding section, but it is evident that closely allied with this is the provision of an adequate number of jets to distribute the oil through the whole of the combustion space.

Many variations of sprayers were made to secure what seemed to be called for. Holes in the sprayer cap were varied in number from 4 to 25. The sizes of holes were varied from 10 to 31 mm. The arrangement of the holes was changed from one outer ring of holes with a centre hole to three rings with a centre hole. The angles of the jets were changed from 80 to 110 degrees, *i.e.*, the angle measured from jet to jet. Changes in the height of the fuel jet body were made to get better distribution, while some sprayers were made projecting well into the combustion space and having holes directed upwards as well as downwards. An interesting feature of this latter may be mentioned in passing. It was feared that this sprayer would suffer from overheating due to its length, but on taking it out after a trial no evidence of overheating could be detected. Apparently the oil passing through it was sufficient to keep it cool. Some sprayers having larger holes on the exhaust side than on the scavenging side to suit the air space above the piston were tried also.

(i) *Varying Number of Holes.*—Some results obtained with varying numbers of holes are shown in Fig. 4. These give results with sprayers almost similar in all other respects. It will be noted that seven and eight holes are better than 10 or five, at the high powers. Without any question five holes are not to be compared with seven after about 200 b.h.p. This is not a surprising result, for there are air spaces left between the jet cones when only five are provided. On the other hand, it is rather surprising that the jet cone appears to object to be crowded together. Whenever the jets began to touch the combustion efficiency fell off, and this was observed frequently. It was rather surprising, too, that a sprayer cap with the holes arranged on two circles invariably gave poorer results than one with the holes arranged on one circle, though on a drawing the distribution of the jets with the former appeared to be better. Examination in the cylinder showed that a sprayer with eight holes in a circle gave jets almost touching one another near the piston.

(ii) *Varying Angle of Jets.*—In addition to the effect of varying the number of holes in the sprayer, distribution is affected

by the angle at which the holes are drilled. The conical top end of the combustion cylinder had an angle of 62 deg. from wall to wall. Angles of jet holes varying from 80 to 110 deg. were tried on different occasions. It was noticeable that the

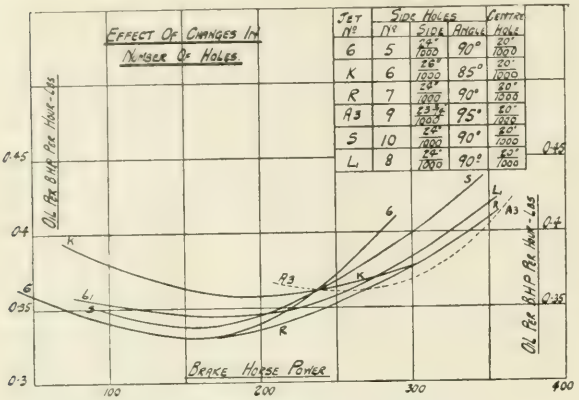


Fig. 4.—Curves showing the Effect of a Change in the Number of Holes as Oil per b.h.p. per hour.

jet marks on the piston—blackened spots—did not change in sympathy with the jet angles. There was a distinct suggestion from these marks that the jets of oil were actually being bent inwards by the boundary walls of the cylinder. Some comparable results obtained with angles of 80, 90 and 100 deg. are given in Fig. 5. The suggestion from these is that 90 deg. is perhaps a little better than 100 deg., while 80 deg. is distinctly worse than 90 or 100 deg.

(*d*) Atomisation, Penetration and Distribution.—Proper distribution of the oil is, of course, closely tied up with both atomisation and penetration, and it is not possible to separate the one effect from the other or the

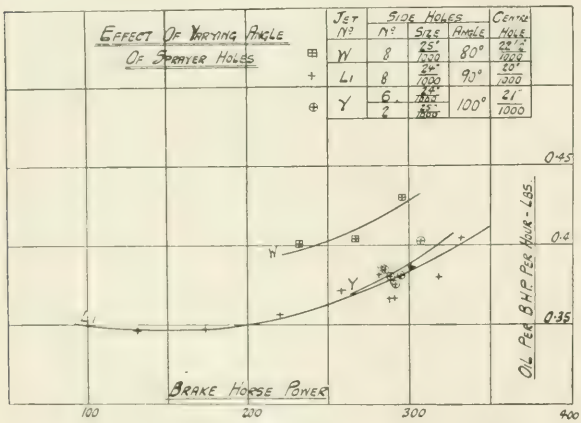


Fig. 5.—Curves showing the Effect of Varying the Angle of Sprayer Holes.

cause of the one entirely from the cause of the other, but the results given above and the experiences obtained in trying to arrive at the best characteristics of a sprayer to suit the particular engine under consideration show that penetration is of first importance; distribution of second importance; and that atomisation is the least important of the three.

Detonation.

At various times in the course of the trials the engine showed definite evidence of extremely rapid combustion or detonation in the cylinder. These occasions occurred in an apparently haphazard manner, and came and went in a tantalising fashion. For a considerable time there was an impression that the combustion in the cylinder was too slow for efficient burning, and it was expected that a condition just bordering on the detonation condition would be helpful.

In the course of the experiments with the engine, conditions were finally reached which, quite accidentally, gave the clue to the conditions necessary. When the engine was detonating slightly, a "ping" could be heard in the cylinder at each combustion period. When the detonation was severe, the noise was very considerable. At every revolution of the engine there was a most severe blow on the parts, just as if the crankshaft was receiving the blow of a large steam hammer. The compression pressures usually varied from 280 to 300 lb. per sq. in., but occasion was taken to reduce this to about 260 lb. and lower. The engine was often started up as soon as steam pressure was raised in the boiler to a little over 100 lb. The warming up of the engine took place naturally by thermal circulation from the boiler (or regenerator) to the engine cylinder. This circulation was certain enough, but sluggish at the commencement. As a result, it happened frequently that the engine started up cold. When the combination of a cold engine and low compression pressure occurred together, it was found that detonation was very marked. When this occurred one day and was repeated the next day, it was felt that what had hitherto been an elusive phenomenon was within reach of explanation. A different sprayer was tried to see if detonation in any way depended upon the type in use, but the detonation occurred just the same. The fuel oil was then changed, but it occurred with Anglo-American oil just as with shale oil. It was noticed that the detonation became less severe as the engine continued to run and warm up. It was also noted that when blowing more air the detonation became more severe. On the other hand, as the air pressure increased, with, say, higher revolutions, the severity of the detonation decreased. The evidence, therefore, was accumulating that detonation depended intimately upon the coldness of the air into which the oil was injected. It happened that on one occasion the compression pressure was reduced to 235 lb. per sq. in., and instead of detonation it was found that missfiring was actually taking place. Quite plainly, therefore, there was a narrow boundary between the one and the other.

A set of cards which shows the one condition merging into the other were obtained, and are shown in Fig. 6. No. 1 card shows pre-ignition taking place, due to oil remaining from the previous stroke, the dotted line indicating what would be a non-firing line. No. 2 shows the existence of the same condition, but the firing is more marked. In No. 3 the condition has changed from one of missfiring to one of detonation. The lateness of ignition will be noted in this case, and in cards Nos. 3A, 4, 5 and 6 show evidence of detonation and no evidence of missfiring such as in No. 1.

In Figs. 7 and 8 a series of cards are reproduced showing very violent examples of detonation at starting up. These

change into more normal firing cards as the load increases and the engine warms up. It will be noted from these cards that severe detonation accompanies a late commencement of ignition, and it may therefore be concluded that it arises from delay in the commencement of ignition caused by an

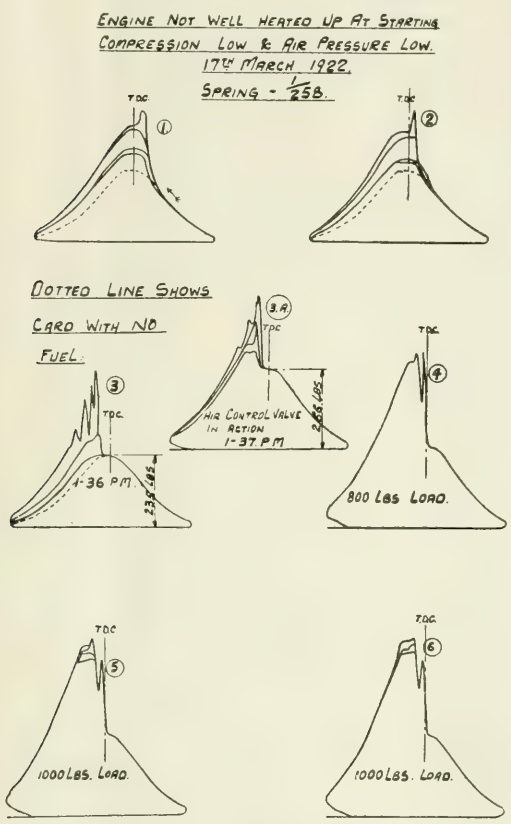


Fig. 6.—Displaced Indicator Cards taken when the Engine was Missfiring.

inadequate firing temperature in the cylinder, followed by a very rapid burning of the oil which has accumulated between the commencement of injection and the commencement of firing, the accumulated oil being apparently an important factor. In Nos. 16 and 17, in Fig. 8, a number of cards have been reproduced together. It is worth noting that in each case the initial ignition line is common to them all. From No. 18 onwards normal conditions are being established. There was no evidence found from any results obtained that detonation improved the combustion efficiency. Detonation appears to take effect upon the first portion of the injected oil, while efficiency primarily is influenced by the completeness with which the latter portion of the oil is consumed.

Scavenging as Affected by Piston Shape.

The piston with which most of the trials were carried out was one having a deflecting lip in way of the air inlet ports, and washing away to the exhaust side as shown in Fig. 9. This piston was one of three shapes tried. Various experiments that were carried out had shown that scavenging was not as good as could be desired, though this was contrary to what the compression samples that were taken from the engine at different times indicated. The following experimental results show, however, that the normal scavenging obtained was good by comparison with what was obtained by reversing this piston and placing the exhaust side to the scavenging air inlet ports and the deflecting lip to the exhaust ports. This alteration was a simple one to carry out, involving mainly a rearrangement of the fastenings for the piston rings,

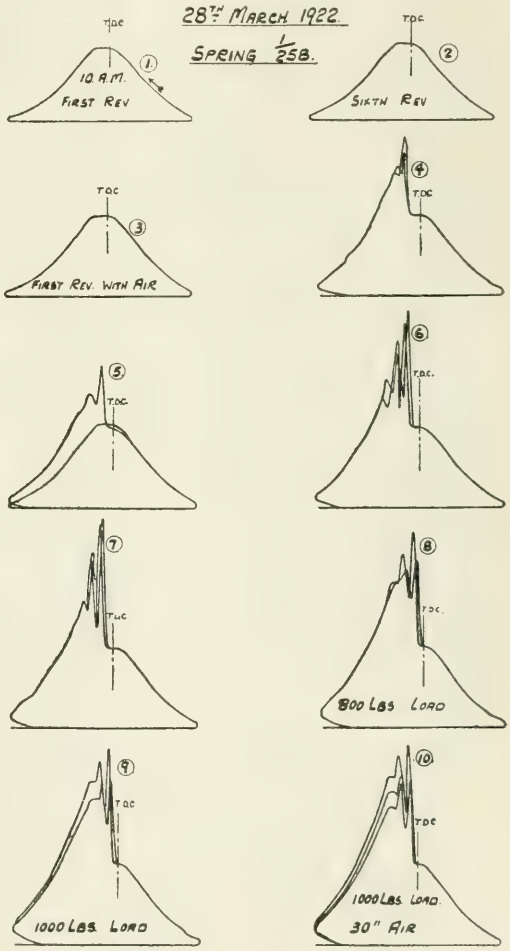


Fig. 7.—Displaced Indicator Cards taken when Starting Up to show Detonation.

yet the results are of considerable importance. With the piston reversed, the first impressions during the test were that the reversal of the piston had not spoiled the results, but as the load was increased the loss in efficiency became evident,

Fig. 9.—The piston with which Trials were carried out.

and it was considered advisable not to increase the brake load beyond 1,330 lb. instead of the usual 1,400 lb. or more. Fig. 10 shows the results obtained, with the piston in the correct way and with it reversed. With the piston reversed, the efficiency falls off very quickly after 250 b.h.p. is reached. It is therefore evident that scavenging can be made worse in this particular engine by the means adopted, and that therefore the deflecting lip of the piston serves a useful and necessary purpose. This, however, does not necessarily apply irrespective of the shape of scavenging ports and inlet passages, or when other features of scavenging are introduced.

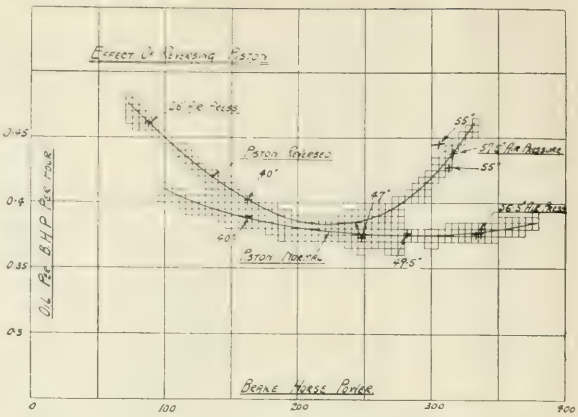


Fig. 10.—Curves showing the Effect of Reversing the Piston.

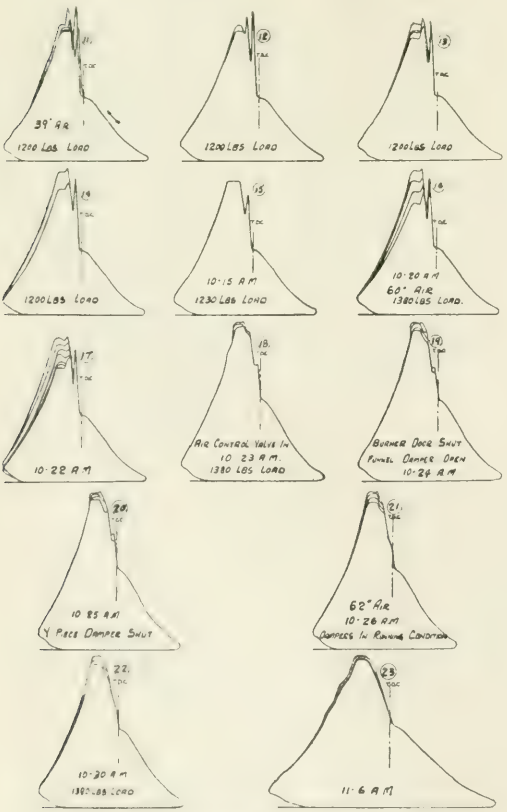


Fig. 8.—Further Cards of Series shown in Fig. 7.

THE ITALIAN MOTOR TANKER "CAPENA."

Particulars of a New Vessel.

We illustrate on pages 301 and 302 the motor tank ship *Capena*, launched from the yard of the Cantieri Officine Savoia di Cornigliano Ligure in a completely finished state, as is the custom in many Italian shipyards, on June 14 last. The vessel, which has been built for the transport of oil in bulk, is constructed, as will be seen from the plans, upon the transverse system of framing with deep web frames. She has dimensions and tonnages as follows:—

Length overall	119·660 metres	=	392·3 ft.
,, b.p.	114·920 ,,	=	367 ft.
Breadth (to inside of plating)	15·70 ,,	=	51·5 ft.
Depth	9·47 ,,	=	31·1 ft.
Load draught	7·36 ,,	=	24·14 ft.
Corresponding displacement	11,200 tons		
Deadweight capacity	7,770 tons		

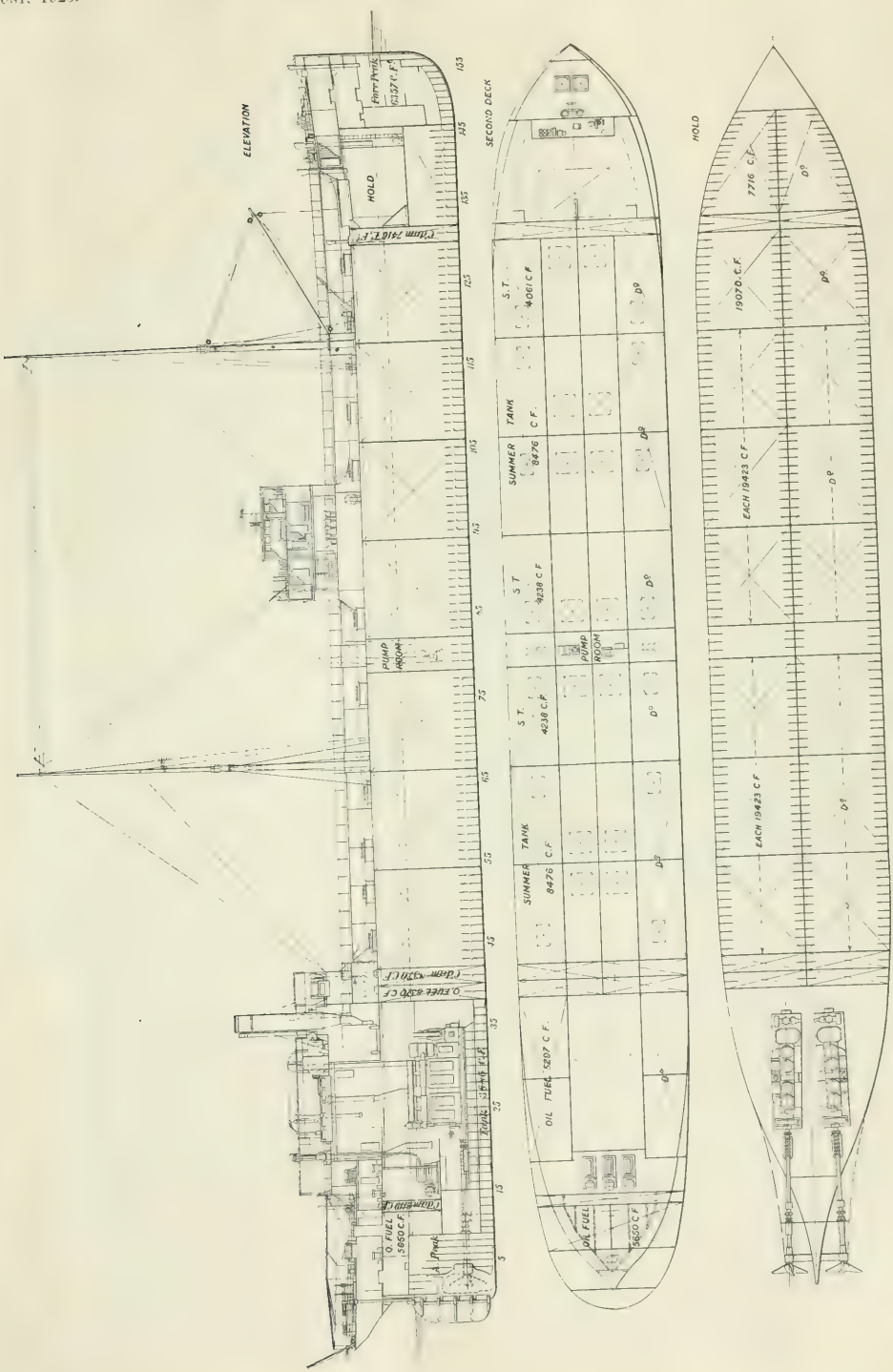
The vessel has 14 main tanks and the usual expansion tanks, fore and aft peak tanks, cofferdams, etc.

The main propelling machinery, as will be seen, consists of twin sets of two-stroke Diesel engines, constructed under licence from Sulzer Bros. & Co. Each unit develops 1,250 b.h.p. at 120 r.p.m., has four cylinders with a diameter of 600 mm. and a stroke of 940 mm., giving the vessel a service speed of 10·5 knots.

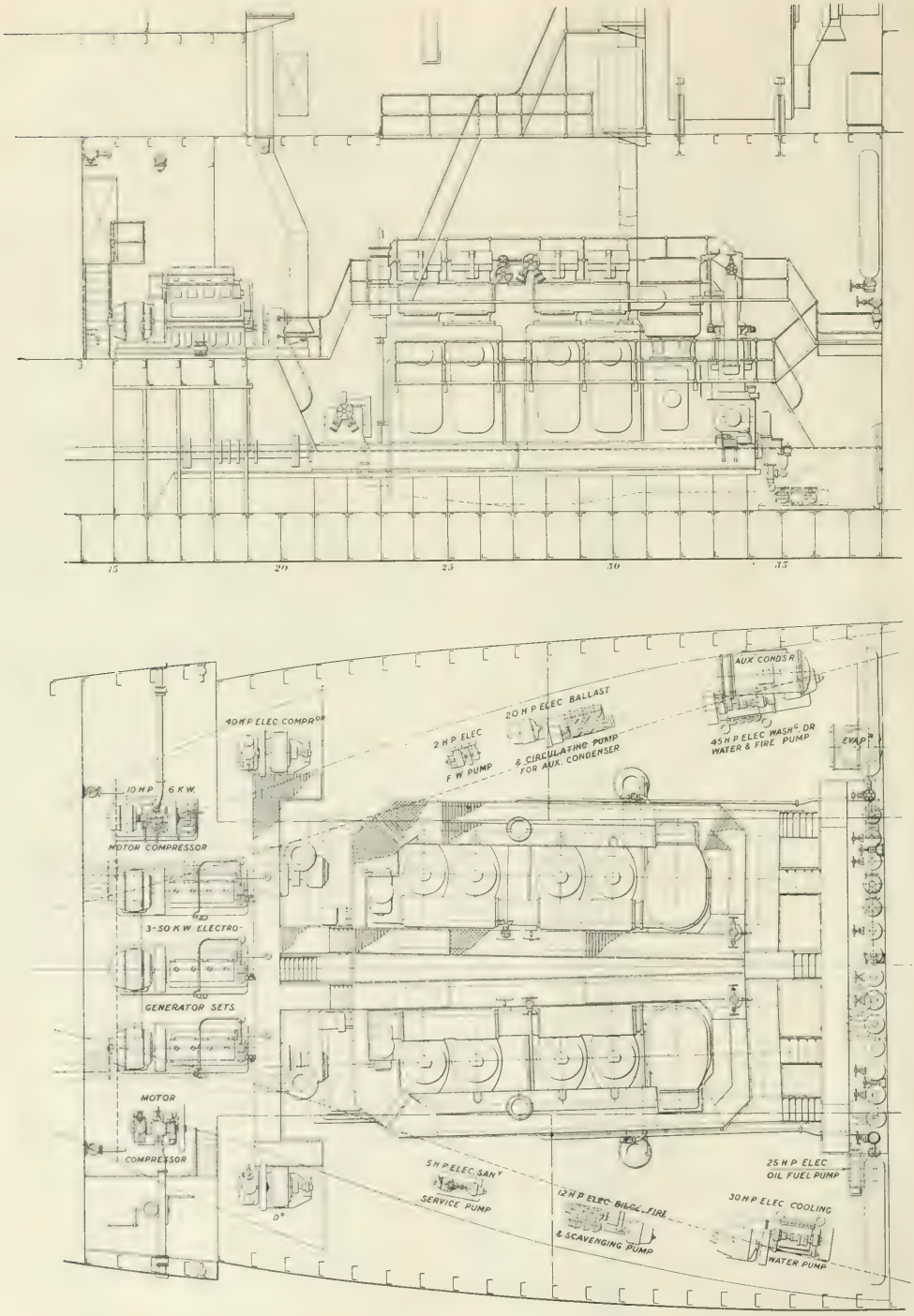
The deck machinery includes one windlass and three electric winches, and the whole of the auxiliary machinery, except that driven off the main engines, is electrically controlled, current being generated by three generating units, each of which consists of an 80-h.p. internal-combustion engine running at 500 r.p.m., direct-coupled to a 50-kw. generator.

The steering engine is controlled by steam from a donkey boiler, which supplies also steam for the coils employed for keeping the oil cargo at a suitable working temperature in cold weather and also for steaming out tanks. The cargo is taken on board and discharged by two direct-acting steam pumps, which also take their steam from the donkey boiler.

The vessel was built for the "Roma" Società di Navigazione, under the special survey of the Registro Italiano and of the British Corporation.



The Italian Motor Tanker "Capena." Elevation and Deck Plans *(see opposite page).*

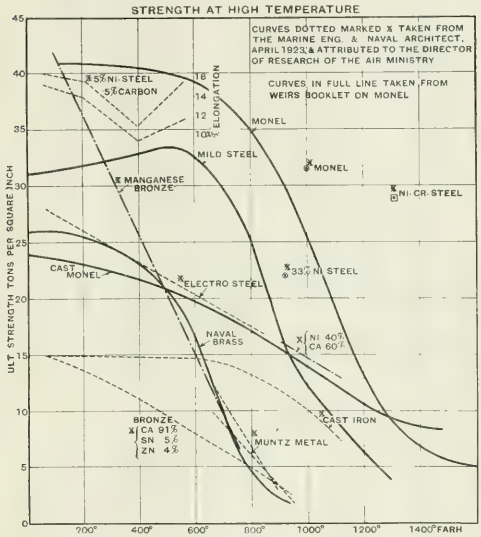

40 H.P. ELEC. COMPR.R
10 H.P. 6 K.W.
MOTOR COMPRESSOR
3-50 K.W. ELECTRO-
GENERATOR SETS
MOTOR
COMPRESSOR
2 H.P. ELEC. F.W. PUMP
20 H.P. ELEC. BALLAST & CIRCULATING PUMP FOR AUX. CONDENSER
AUX. CONDS.R
45 H.P. ELEC. WASH.G DR. WATER & FIRE PUMP
EVAP.R
5 H.P. ELEC. SAN.Y SERVICE PUMP
12 H.P. ELEC. BILGE, FIRE & SCAVENGING PUMP
25 H.P. ELEC. OIL FUEL PUMP
30 H.P. ELEC. COOLING WATER PUMP

The Motor Tank Ship "Capena." Elevation and Plan of Machinery Space.

MONEL METAL FOR HIGH TEMPERATURE WORK.

A Brief Resumé of its Properties.

We reproduce below some interesting curves showing the ultimate tensile strength of monel metal at varying temperatures, which have been forwarded to us by G. & J. Weir Ltd., Cathcart, Glasgow. On the chart will also be noticed the curves reproduced from an article entitled "Temperature and the Strength of Materials," which was published on page 125 of our April issue, and it is interesting to compare these with the curves for monel metal. Hot rolled monel metal, it will be noted, has an ultimate tensile strength of over 41 tons per sq. in. at 0° C.; this is greater than the ultimate tensile strength of mild steel by some 10 tons. The corresponding ultimate tensile strength of cast monel metal, it will be noted, is under 25 tons per sq. in.; but at 800° C. (1,472° Fahr.) the figure for the cast metal is greater than that for the hot rolled metal. The curves shown on the chart are based on the results of experiments conducted at the Cathcart works of G. & J. Weir Ltd., and they serve to bring out the great strength of monel metal at high temperatures, greater, it will be noticed, at 700° C. than that of either mild steel, manganese brass or naval brass. We understand that G. & J. Weir, Ltd., who are the British and European concessionaires for monel metal, are supplying large quantities of the metal for valves, valve seats, spindles and all parts controlling highly superheated steam, for which purposes it is especially suited.


STRENGTH AT HIGH TEMPERATURE
CURVES DOTTED MARKED X TAKEN FROM THE MARINE ENG. & NAVAL ARCHITECT, APRIL 1923 & ATTRIBUTED TO THE DIRECTOR OF RESEARCH OF THE AIR MINISTRY
CURVES IN FULL LINE TAKEN FROM WEIRS BOOKLET ON MONEL
ULT STRENGTH TONS PER SQUARE INCH
% ELONGATION
55% NI STEEL 5% CARBON
MONEL
MILD STEEL
MONEL
MANGANESE BRONZE
NI-CR-STEEL
CAST MONEL
ELECTRO STEEL
33% NI STEEL
NAVAL BRASS
NI 40% CA 60%
BRONZE CA 91% SN 5% ZN 4%
CAST IRON
MUNTZ METAL
FARH

Curves showing the Ultimate Tensile Strength of Monel Metal.

Monel metal is a natural alloy of nickel and copper smelted from ore found in large quantities in Canada. Its composition is approximately 67 per cent. nickel, 28 per cent. copper, and 5 per cent. of other materials. Monel metal has a special value in the engineering world by virtue of the following properties:—

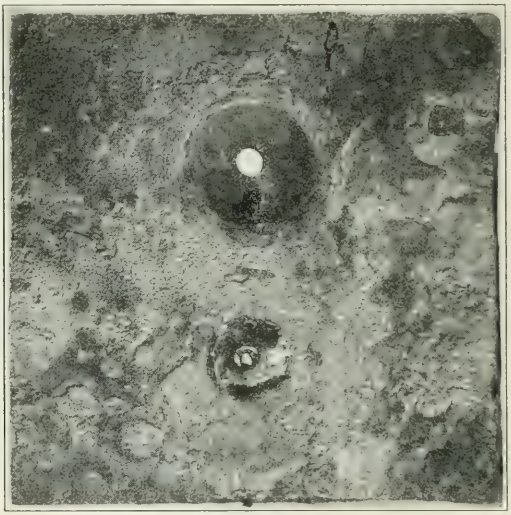
(*a*) A very high resistance to corrosive action by salt water, atmospheric conditions, alkalis and also to some acids.

(*b*) Extreme toughness combined with a high tensile strength, both in cast and forged material, in the latter case exceeding mild steel.

(*c*) The high proportion of strength retained when it is subject to high temperatures.

(*d*) The facility with which it can be machined, cast, forged, rolled into sheet or drawn out into fine wire.

Steel in some of its many forms is stronger than monel metal and has a higher limit of proportionality, but when subject to high temperature its strength falls off to a greater extent than monel, as will be seen on reference to the curves.



The Effect of Heat upon Monel Metal.

One of the most important characteristics of monel metal however, is the fact that superheated steam at a temperature of 750° Fahr. has no appreciable effect on it. At combustion temperatures, say, of 900° C., monel metal suffers very little by scaling action, and at such temperatures this action is probably less with monel metal than with any other engineering material and the proportion of strength retained much greater.

The following are some of its principal characteristics —

Melting point	1,360° C.
Specific gravity	8·82.
Shrinkage allowance for castings	$\frac{1}{4}$ in. per ft.
Coefficient of expansion	·0000137 per 1° C.
Electrical resistivity	48 microhms per c.c.

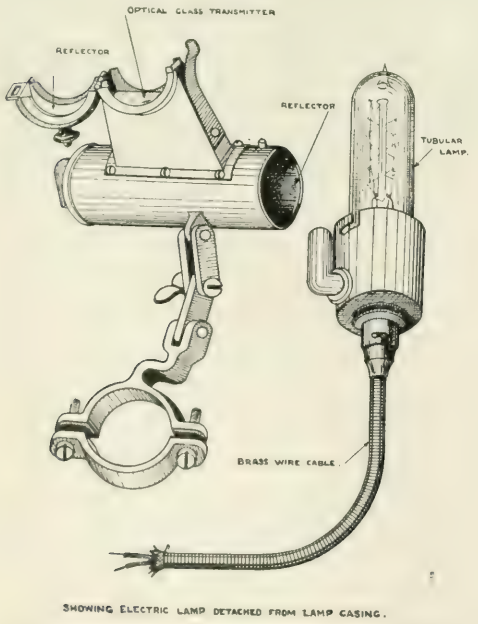
The photograph reproduced above shows the superior way in which monel metal stands up to fire action. It was taken after the plate had been in the furnace of a works boiler for three months in direct contact with the fire. The upper rivet, with the undamaged head, is of monel metal, while in the lower rivet hole can be seen all that remains of the copper rivet, which was originally the same size as that of the monel metal one.

AN INTERESTING GAUGE GLASS ILLUMINATOR.

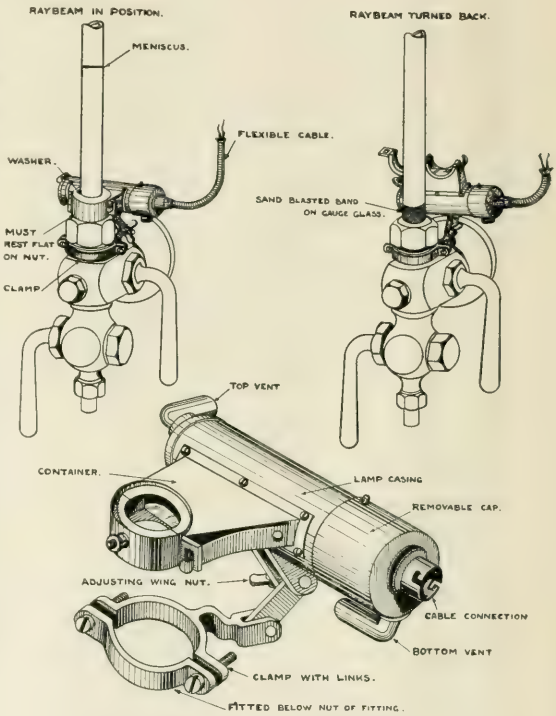
Description of a Device to Facilitate Gauge Glass Reading.

It is well known that in a great many instances the strain which is put upon the stoker watching the gauge glass or the gauge glasses of marine boilers is very considerable. Attempts have been made in various directions to produce a gauge which will facilitate the reading of the water column, but most of these have not proved successful in actual practice for many reasons. We show below an illustration of the "Raybeam" gauge glass illuminator invented by Ronald Trist & Co. Ltd., Dinneford House, 12, Clipstone Street, London, W.1, and recently placed on the market by them. As will be seen, it consists of a small casing which can be readily clamped to any existing gauge glass. This casing holds an electric bulb suitable for all current voltages; the light rays are concentrated on a tinted glass unit, the glass unit itself touching the gauge glass proper. In the ordinary way, most of the light rays would be transmitted outside of the glass and very little illumination of the meniscus would result. But a further ingenious idea, *i.e.*, a sand-blasted circle at the point where the glass unit meets the gauge glass, results in the major portion of the light rays being transmitted through the water achieving the desired result, *i.e.*, a red floating band on top of the water column which floats up or down in accordance with the movement of the water in the gauge glass. Should the gauge glass break, the interposed optical transmitter glass, which is a thick plate glass, will prevent any damage being done to the electric light bulb.

We understand that the makers also provide a combined fitting consisting of a protector and an illuminator, *i.e.*, the lower portion of the protector is a casting consisting of the "Raybeam" illuminating device which holds the glass of the protector and is shaped to rest on the nut of the gauge glass fitting proper.



The Raybeam Gauge Glass Indicator-Lamp detached from Casing.



General Outlay of the Apparatus.

In the case of water-tube boilers where the gauge glass is fitted at a very great height above the floor level, it is frequently impossible to obtain a proper angle of view, and for that purpose an additional reflector fitted behind the gauge glass at a suitable angle will permit the reading of the glass even if the operator stands right below the gauge glass at a distance of 20 to 30 ft.

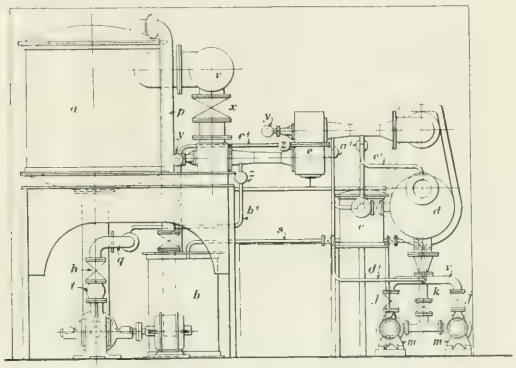
Though this appliance has only recently been placed on the market, we understand that highly satisfactory results have been obtained.

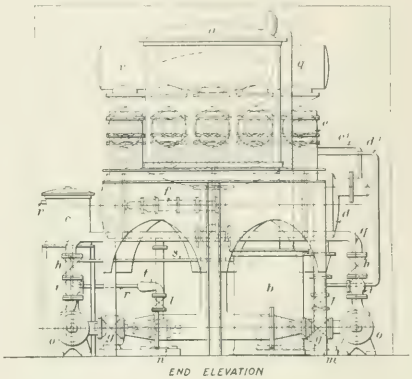
BRITISH STANDARDISATION RULES FOR ELECTRICAL MACHINERY.—The British Engineering Standards Association announces the withdrawal of B.S. Specification 72—1917 from circulation. This document is now under revision and will be divided into the following sections, each of which will be issued as a separate publication as and when ready:—(*a*) Industrial Machines; (*b*) Large Machines; (*c*) Transformers; (*d*) Rotary Converters; (*e*) Traction Motors. These sections are in course of preparation.

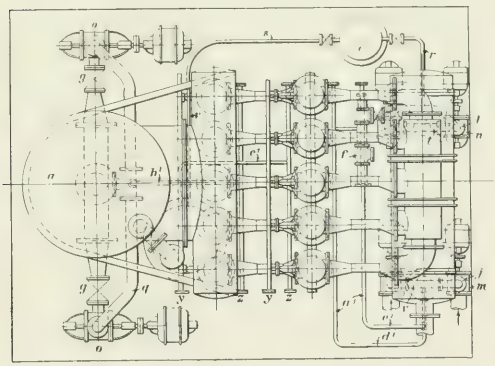
A STEAM REFRIGERATING PLANT.

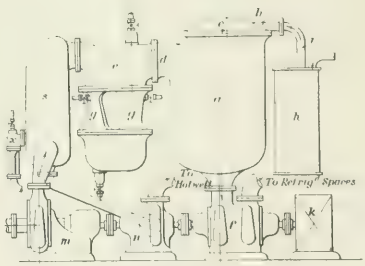
Details of a System Based on Water Evaporation.

A good deal of interest has been aroused during the last few months in French shipping circles in connection with a steam refrigerating machine built by the Société des Condenseurs Delas, according to a design patented by them. The working principle of the plant is based on the evaporation of water.









The Delas Steam Refrigerating Plant.

a Evaporator (insulated).
b Brine tank (insulated).
c Feeding bottle.
d Condenser.
e Evaporators; refrigerating ejectors.
f Air ejector of the condenser.
g Brine pump suction sluices.
h Brine pump discharge sluices.
i Refrigerating air stop valves.
j Discharge sluices of circulation pumps to condenser.
k Suction sluice for condensed water from condenser.
l Water discharge sluices to feeding bottle.
m Condenser circulation pumps (sea water).
n Suction pumps for condensed water.
o Brine pumps.
p Brine suction piping (evaporator tank).
q Discharge collector for brine to the air refrigerators.
r Water discharge piping (suction pump to the feeding bottle).
r' Feeding bottle waste nozzle.
s Fresh water complementary piping (feeding bottle to brine tank).
t Suction pump discharge collector.
u Circulation pump discharge collector.
v Refrigerating ejectors suction collector.
x Refrigerating ejectors suction sluices.
y Steam entrance collectors to refrigerating collectors.
z Fore diffuser collectors (cooling).
a' Aft diffuser collectors (cooling).
b' Fore diffuser brine entrance.
c' Fore diffuser brine outlet.
d' Aft diffuser circulating water entrance.
e' Aft diffuser circulating water outlet.

It comprises one or several steam refrigerating ejectors of the Delas patent type (*g*) (the letters in the following description of the plant refer only to the diagrammatic sketch at the bottom right hand corner of the above drawing), which produce vacuum in an evaporator (*a*) into which the liquid which is to be frozen (uncongealable brine) is fed. The partial vaporisation of the brine cools it to a temperature corresponding to the pressure existing in the evaporator. The steam produced is conveyed through the piping (*d*) and (*e*) by the live steam supplied to the refrigerating ejectors and both flow into a condenser (*s*), generally a jet condenser, in which the vacuum is maintained by a steam ejector of the Delas type (*x*).

A pump (*o*) is provided for exhausting the injected water (in case of a condenser of the jet type) or the condensation water (in case of a surface condenser being fitted).

In case the water available is not at sufficient pressure, another pump (*m*) is supplied for ensuring the circulation of the condensing water. The cold brine collected from the lower

(*Continued on p.* 310.)

VANADIUM STEEL FOR ENGINEERING PURPOSES.

The Influence of Vanadium as a Steel Ingredient—Sources of Supply of Vanadium—The Range of Application of Vanadium Steel—Some Remarkable Results of Tensile Tests.

Very considerable progress has been made during recent years in the production of alloy steels of very high quality, and although such elements as chromium, cobalt, nickel, tungsten and others have been found to add very considerably to the mechanical properties of steel, whether introduced individually or in combination or whether in larger or smaller quantities, no single element at present known appears to possess the power of improving the quality of steel to anything like the extent which the solitary addition of a very small percentage of vanadium will do. Though the advantages of vanadium as a steel ingredient have been known for nearly thirty years, its general use as an alloy has until quite recently been considerably restricted by the comparative scarcity of the deposits in which it has so far been found, and consequently owing to its classification amongst the rare metals of the world much detailed information in regard to its properties was unavailable. Discovered first amongst the brown lead ores in Mexico in 1804, and later in the Taborg iron ores in Sweden, its extreme rarity forbade its use, although about sixty years ago small quantities were utilised in the manufacture of indelible inks. Attention was first drawn to its remarkable metallurgical properties in 1896, when some test armour plates containing a fractional quantity and manufactured by the Firminy Steel Works in France showed exceptional qualities, but owing to its extreme scarcity at that period full advantage could not be taken of the knowledge thus acquired. In fact it was not until the discovery of very rich and extensive deposits of an ore called patronite, containing about 20 per cent. of vanadium, in Peru, about 1905, that the commercial manufacture of alloy steels containing vanadium first became possible, and from being one of the rarest elements vanadium has since, though only comparatively recently, become probably the most important used in the manufacture of alloy steel. So extensively adopted has it now become that it has been estimated that towards the end of the war the production of vanadium steel amounted to a figure approaching one million tons a year. Of this quantity, the vast majority was produced in the United States largely owing to the fact that practically the whole of the vanadium production of the world is controlled by the Vanadium Corporation of America, and though its value is becoming much better realised in this country, it has not been utilised in Europe to more than a very fractional quantity compared with its applications in the former country.

Vanadium as an Alloy.

The value of vanadium lies in the fact that its addition to steel in very small quantities ranging between 0·04 to 0·60 per cent. assists in removing occluded oxygen and nitrogen, and that it combines with the steel to the very great advantage of the latter, depending in result on the proportion, which, however, even in British high speed tool steel practice, does not exceed from 1·0 to 1·5 per cent. at most. Its action is somewhat similar to that of tungsten, but may readily be from ten to twenty times more powerful even when added to carbon steel in much smaller proportions. It confers great toughness on the steel and has the effect of increasing the elastic limit and the ultimate stress to a very considerable degree without sensibly reducing the ductility even when added alone, but in association with tungsten, and particularly chromium, the result is no less remarkable. It is particularly in the presence of much higher temperatures than are commonly in use in steam engineering that the stabilising properties of vanadium are to be found.

In Great Britain the earliest investigations of its influence on steel were conducted by Professor Arnold, of Sheffield University, in 1899-1900, and in the course of his tests it was shown that the addition of only 0·3 per cent. of vanadium to a plain carbon tool steel increased the turning capacity of the material by no less than 75 per cent. more than did the addition of even 3 per cent. of tungsten to the same steel. These tests, however, while indicating the probability that vanadium was even then the element which, together with carbon, was the most powerful for alloying beneficially with steel, and further tests on chrome vanadium steel, published in a paper by Messrs. Sankey and Smith read before the Institution of Mechanical Engineers in 1904, not only confirmed Professor Arnold's results, but indicated that steel containing vanadium possessed remarkable properties of resistance to fatigue. It was not till some years afterwards that the discovery of vanadium ore deposits in Peru and in South Western States of the United States admitted of its commercial use on a large scale.

In a paper read before the Iron and Steel Institute in 1915, Dr. Arnold gave instances of some very remarkable results accruing from the addition of various percentages of vanadium to nearly pure steel. This report should be studied by all interested in the subject. Compared with pure ingot iron possessing a maximum strength of 21 tons and an elastic limit of 12 tons per sq. in. with a reduction in area of 76 per cent., the addition of 0·85 per cent. of vanadium raised the former by 5 tons and the latter by as much as 8 tons, the reduction in area then being 72 per cent. Taking the case of a nearly pure steel containing 1·10 per cent. of carbon with an elastic limit of 30 tons and an ultimate strength of about 60 tons per sq. in., and having an elongation in 2 inches and a reduction in area of about 8 per cent. in each case, the addition of 0·14 per cent. of vanadium raised the ultimate strength by 7 tons and the elastic by 13 tons; 0·29 per cent. raised the respective figures to 76·2 and 43·2 tons, while 0·58 per cent. raised them to 85·2 and 64·8 tons. A further increase in the vanadium content seemed to show that little further advantage was to be gained by going above 0·6 except in connection with tool steels. Dr. Arnold quoted other remarkable instances of the influence of vanadium when other elements were present. Thus, in the case of a chrome steel, a small percentage of vanadium increased the elastic and the ultimate strength by 13 and 14 tons respectively, or from a maximum of 41 to one of 55 tons per sq. in., the elongation being then 26 per cent. One particular steel, on receiving an addition of 1 per cent. of tungsten, had the ultimate stress increased by 14 tons; the same steel alloyed with only 0·25 per cent. of vanadium had the ultimate stress increased by 30 tons. Numerous other instances can be found in the paper referred to. Broadly speaking, the smaller proportions of vanadium confer the element of toughness, while larger proportions render the steel more suitable for tool purposes. It is undoubtedly a very remarkable ingredient which by the addition of only some 7 lb. to 1 ton of pure steel will increase the ultimate strength by no less than 27 per cent.

But one very remarkable property associated with the use of vanadium lies in the fact that the powerful effect of this element in increasing the elastic limit and the tensile strength of steels

to which it is added, and that without lowering the ductility, admits in the case of many forgings of the elimination of the quenching and tempering operations with all the attendant possibility of damaging the forging in the former case, and yet nevertheless of obtaining the corresponding physical properties specified for other steels after quenching and tempering. Thus, for instance, in lieu of the usual 3·5 per cent. of nickel in shaft forgings, the United States Navy Department now allows the use of a plain carbon steel with 0·15 to 0·18 per cent. of vanadium, and simple annealing takes the place of the more complicated operations. With simple annealing, a propeller shaft 25 ft. long and 13 in. in diam. containing 0·43 carbon, 0·65 manganese and 0·18 vanadium has shown an elastic limit of 30 tons, an ultimate strength of 43·3 tons with an elongation in 2 in. of 26 per cent. and a reduction of area of 59 per cent., while a similar rotor core and shaft 6 ft. long by 22 in. diam., but only containing 0·04 vanadium, has shown 22·3 and 38·8 tons respectively with 25 and 40 per cent. elongation and reduction.

Sources of Vanadium Supply.

More than 90 per cent. of the world's vanadium production has hitherto come from the unique deposits of Minas Agra near the crest of the Andes in Peru, close to Cerro de Pasco. At this point it is found in the form of a vanadium sulphide called patronite, which is so far the richest quality found. Roscoelite, a vadiniferrous mica generally containing less than 3 per cent. of vanadium oxide, is found in Colorado, as is also carnotite, which is a hydrous potassium-uranium vanadate. On account of the low vanadium content in the former the production here is very limited, while the process in respect of the extraction of the various elements in the latter is costly and complicated. Although vanadium ores are found under a great variety of circumstances no really large deposits, such as those in Peru where the vanadium content is high, have been discovered. Only traces have been found in Great Britain; these occur in Scottish oil shales and the ashes of certain forms of coal, and to some extent in the form of mottramite in Derbyshire. In Sweden, in an occurrence similar to the British coal ash case, it has been stated that the value of the recovered vanadium is considerably greater than that of the coal as fuel. This may well be, for the present market price of ferro-vanadium in this country is roughly 17s. per lb., or a trifle of £1,900 per ton! The price of nickel to-day is about £130 per ton. Traces have been found in France, Australia, Argentina and elsewhere, notably in South Africa, where decloizite, a vanadium-bearing lead ore, has recently been discovered in apparently good commercial quantities. Rare as vanadium was only 10 years ago it cannot be said to be so to-day, and the growing appreciation of its qualities is enforcing a more rigorous search in districts in which its presence has not previously been suspected, or if known, was ignored. The compounds have long been known; it was only since its value as a steel ingredient was realised that any real use was found for the metal. In appearance vanadium metal is a silver-white lustrous metal with an atomic weight of 51, compared with chromium 52 and nickel 58·68. The melting point is about 3,130° Fahr., compared with 2,770 deg. and 2,640 deg. for chromium and nickel respectively. It is not used except to a very limited extent in the pure form, and when required for steel alloying is added in the form of ferro-vanadium.

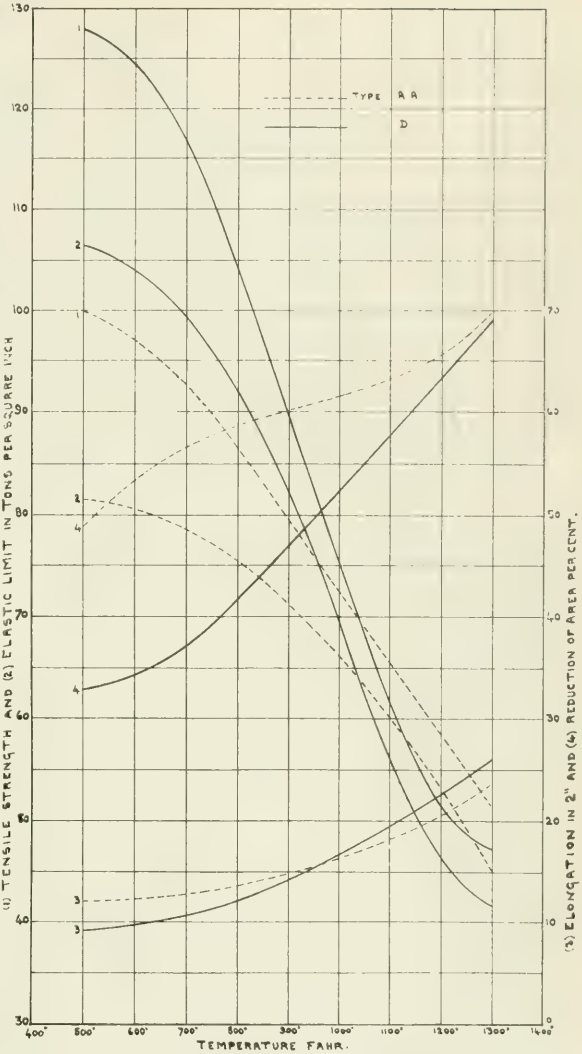


Chart showing the effect of Heat upon the Physical Properties of Vanadium Steel.

Applications of Vanadium Steel.

By far the widest use of vanadium is made in the United States, Great Britain, France and Germany absorbing a comparatively small proportion of the world's output. The first authentic record of the use of vanadium in metallurgy was in the case of armour plate in France in the middle of the late 'nineties, and during the recent war the quantity of light vanadium armour plating turned out in the U.S.A. was very considerable. United States submarine-engine chrome vanadium crankshafts were widely used and gave great satisfaction after the previous nickel steel shafts had been a cause of frequent breakdown. These shafts are subjected to high stresses and to considerable fluctuations of torsional stress, and it was not until the adoption of heat-treated chrome

vanadium steel that the trouble was entirely stopped. The tests of these latter showed an elastic and an ultimate strength of 37·6 and 48·8 tons respectively with an elongation of 25·9 per cent. and an area reduction of 58 per cent. These shafts were 7 in. in diam. with a 3 in. hole and were made in two pieces each 8 ft. 6 in. long with three throws in each. The use of vanadium is not confined to forgings. A very large number of cast steel locomotive frames have been made, some of them as long as 36 ft. overall with a 6-in. square section and weighing about 6 tons. In this case the increased strength of the vanadium cast steel compared with the ordinary carbon steel enabled manufacturers to cope with the increasing size and power of locomotives without unduly increasing the frame sections. Average tests of these cast vanadium steel showed elastic and tensile strengths of 20·2 and 35·2 tons with 24·7 and 46·4 per cent. elongation and reduction of area. Forged turbine drums and rotor discs are now commonly made in the United States in vanadium steel. Some extremely good results have been obtained with this material in its application to heavy duty roller bearings, aeroplane and motor car engine crankshafts, connecting rods, torpedo air flask forgings, and many other purposes in which very high quality steel is essential. In spring work, especially, the resistance to fatigue which can be obtained has given great satisfaction.

Some Remarkable Test Results.

It is, however, in the applications wherein high temperatures are involved that the use of vanadium is of particular value. The writer was accorded permission by Vanadium Limited, of 64, Victoria Street, London, to reproduce a diagram showing the physical properties of vanadium steel at different drawback temperatures. The original charts for chrome-vanadium steels of Type AA and D were plotted separately, but in the attached diagram the test results have been superimposed. The test pieces were $\frac{7}{8}$ in. in diam. Those for type AA were annealed at 1,625° Fahr. in air and quenched at 1,625° Fahr. in water; those for type D were annealed at 1,560° Fahr. in air and quenched at 1,560° Fahr. in oil. The original charts were plotted by the Metallurgical Department of the United Alloy Steel Corporation from an extensive series of tests made in that company's testing laboratories. The results are self-explanatory. The curves, however, are of very particular interest in that the tests have been carried out over a wide range of, and up to a very high, temperature, and there are few published records indeed in which corresponding data is available. The elastic and tensile strengths are exceptionally high at the upper temperatures. Provided always that great care is taken to eliminate the disturbing factor of time by carrying out each test under as nearly the same conditions of heating and loading as possible, such a diagram gives a general indication of the relative ability of different materials to meet certain temperature conditions, and in this case it does undoubtedly indicate that very great progress has been made in the production of alloy steels to withstand high temperatures. On the other hand, from the point of view of the practical designer, this diagram does not—nor was it intended to—show the durability or working life of these materials at various temperatures. Valuable as the information is and remarkable as the resistance of the material is for design purposes, what is required is a time-temperature chart under different conditions of loading. That is to say, while from the given data either the AA or the D chrome-vanadium steel appears to possess an ultimate tensile strength of 70 tons per sq. in. at a temperature of 1,040° Fahr., the information which the would-be user of an alloy steel at this temperature really requires is the length of time under which the material will resist a given stress—say one of 10 deg. of 14 tons per sq. in., giving factors of safety of seven or five in the ultimate, and also the extension involved during that period. These tests, however, are very difficult to carry out in view of the length of time throughout which the high temperature must be kept within narrow limits, and the enormous number of observations involved. When to these are added the permutations and combinations involved in alterations to composition and different methods of heat treatment, it will readily be seen that the amount of research work which remains to be done on the properties of alloy steels is still colossal.

Conclusion.

What has been done very completely is the proof of the influence of vanadium as the sole alloy ingredient in combination with carbon. That it avoids, in the case of certain heavy forgings, the quenching and tempering treatment which is necessary to obtain the same mechanical properties in the case of other steels is certainly very important. On the other hand, the cost of ferro-vanadium must remain very high compared with other ingredients owing to the restricted deposits of anything approaching a rich quality of ore. But so small is the percentage of vanadium required to produce an identical result compared with that of other ingredients that this disadvantage is very largely offset, and in the actual process of working in the course of manufacture, both in the forge and in the machine shop, vanadium possesses qualities that not only render it easier to use, but also it would appear that it has the property of bringing out the qualities of other ingredients to an extent that is difficult to produce in its absence. This is very particularly the case when molybdenum is employed, the influence of vanadium being then largely in the direction of the prevention of cracking during the hardening operations employed with molybdenum steel.

In the treatment of the numerous forms of ore in which vanadium is often found in small quantities there is still much to be learnt before the extraction processes can be regarded as entirely satisfactory. There seems to be no doubt that in several cases the extent to which it is really worth while to attempt to extract the vanadium content must depend very largely on the concomitant value and utility of the other elements present. In the case of patronite, no attempt is made to obtain anything beyond the roasted product of the ore at the mine, in which condition it contains somewhere between 40 and 50 per cent. of vanadic oxide and a trace of sulphur. This product is shipped to the United States for the subsequent treatment by which vanadium itself or ferro-vanadium is obtained, but for the carnotite and roscoelite ores of Colorado, Utah and New Mexico in which a certain amount of uranium and radium are present, arrangements which need not be described here are necessary to extract all three elements, and it is by no means inconceivable that cases may arise in which even vanadium will be extracted rather as a by-product than as the primary object in itself.

Turbines for the Japanese Navy.

The Uraga Dock Company of Japan have placed with the Vickers' group, through Vickers Limited, Barrow, as main contractors, an order for the turbine propelling machinery required for a large destroyer they are building for the Japanese Navy. The turbines, twin-screw, 39,000 s.h.p., will be of Metropolitan-Vickers design. For some time the Japanese Navy have been interested in the design and special features of the Metropolitan-Vickers impulse turbine, and but for this fact the order might never have come to this country as turbines of the Brown-Curtis or Parsons type would probably have been built in Japan. The turbine rotors and diaphragms will be manufactured at the Metropolitan-Vickers Electrical Company's Trafford Park Works, Vickers Limited, Barrow, supplying the turbine casings and the gears.

NOTES FROM THE FOREIGN PRESS.

Specially abstracted for "The Marine Engineer and Naval Architect."

The Economical Steam Speed for Turbines.

The aim of this article is to illustrate the various factors which influence the diameter of the turbine steam pipes and by their comparison to show how the optimum diameter may be simply obtained for incorporation in future designs. Two best diameters are distinguished, that which corresponds to the smallest steam consumption and that which, taking into account the initial cost of the relevant details, corresponds to the economical diameter. Once these diameters are obtained the most economical corresponding steam speeds are also investigated. The investigation is applied to the cases of an installation having steam pressures 16 and 10 atm., temperature = 350° C. producing 8,500 kw., with an hourly steam consumption of 45,000 kg., and secondly, 750 kw. on a steam consumption of 5,000 kg.

The speed corresponding to the diameter of lowest steam consumption is lower than that corresponding to the most economic diameter. These speeds are much less than those usually recommended, *i.e.*, 80 to 100 m./sec., and are less than 48 m./sec. The best steam speed is higher and more economical, the higher the steam temperature the lower the pressure, and the smaller the turbine. For a given turbine steam pressure and temperature the economical speed is higher the less the resistance caused by valves and water separators. This fact is clearly shown in a detail example and brings out the superiority of a new type of valve, called the Kaswa valve, over the ordinary type for steam turbine work. With this valve for large turbines having separators the best speed varies from 33 to 35 m./sec., while with the ordinary valve the best speed is much lower and hence less efficient, and varies from 19 to 25 m./sec.—*K. Schmidt, Schiffbau*, May 30, 1923, p. 554; 3 pp.; 3 ff.

Design of Motor Boat Propellers.

This article is devoted to the design of motor boat and especially motor fishing-boat propellers. Although the text of the article thus deals principally with small boats yet the accompanying design data are remarkably complete. These data are given in chart form and embody a very comprehensive model propeller experiment research programme. This research embraces two, three and four-bladed screws and is extended over a range of face pitch ratio of from 0·60 to 1·50. For all the screws a boss diameter 16·67 per cent. of the screw diameter is used. For the two-bladed screws separate charts are given for 19, 28, 37 and 47 per cent. disc area ratios. Three-bladed screws have separate charts for 28, 42, 56 and 70 per cent. disc area ratios, while for the four-bladed screws separate charts are given for 37, 56 and 75 per cent. disc area ratios. The lay-out of the charts has been specially designed to accommodate the Diesel-engine powering problem. For his independent variable, the author uses what he calls the revs.-torque constant, and which equals $n.\sqrt[3]{\frac{M}{V^5}}$ (in which n = revs. per sec., M = torque in meter-kg., and V = speed of water relative to propeller in m./sec.). On this base curves of nominal slip $\frac{nD}{V}$, and propeller efficiency for constant pitch ratio, are plotted. The case of an internal-combustion engine which develops its maximum torque at given revolutions can be thus very simply and directly dealt with. As an example, the case of a 3·3-ton motor boat having a 5 b.h.p. engine capable of developing its full power at 550 revs. per min. is considered. The boat's speed is 6·53 knots, and with a wake fraction of 0·15 the value of the revs.-torque constant becomes 2·91. From the charts (which are eleven in all) the efficiencies, slip and diameter are obtained and tabulated for all screws having this revs.-thrust constant. From each table the best screw is obtained and finally, it is found that the best pitch ratio is unity, that a 28 per cent. D.A.R. 2-bladed screw of diameter 0·493 m. has the highest efficiency, *i.e.*, 64 per cent., that a 42 per cent. D.A.R. 3-bladed screw of diameter 0·471 m. is slightly less efficient, *i.e.*, 62·8 per cent., and finally, that a 56 per cent. D.A.R. 4-bladed screw of diameter 0·462 is slightly less efficient, *i.e.*, 61·5 per cent. These three screws are, of course, the best of their respective classes.

A final example of the design of propeller for a motor cutter of 10 tons displacement is given in the second and concluding portion of the article. The motor chosen is one of 10 b.h.p., which develops its full power at 500 r.p.m. In this case a speed of 6·5 knots can be expected, and this, with a wake of 15 per cent., produces a revs.-torque constant of 3·5. For this value the whole range of disc area ratio, pitch ratio for two, three or four blades, is investigated. It is again found that a best pitch ratio exists for all propellers, and in this case the value is 0·90. The two-bladed 28 per cent, D.A.R. screw is most efficient, and with a diameter of 0·619 m. the efficiency is 61·7 per cent. The best four-bladed is least efficient. It has a D.A.R. of 56 per cent., diameter 0·580, and efficiency of 58·1 per cent.—*Dr. K. Schaffran, Het Schip*, June 15 and 29, 1923, pp. 147, 160; 7½ pp.; 11 ff.

The Contra-Propeller.

This article, although not forming part of the ordinary text of the journal, is most interesting and gives some very complete information on the latest developments of the contra-propeller. Up to the end of June, vessels of a total indicated horse-power of 60,000 have been fitted with this device and with uniform successful results. Interesting details of model experiments carried out by the Hamburg tank for a 6-knot river vessel are given. The quasi-propulsive coefficient without contra-propeller was found to be 48 per cent., while with it, it was 58 per cent. This amounts to a saving in power of 17 per cent. The performances of various vessels recently fitted with the "contra" are also given. The savings in power range from 14 to 20 per cent. The reliability as distinct from the efficiency of the device is being more and more established. The contra is no more susceptible to damage than the ordinary propeller. Apart from reducing the requisite horse-power no vibration has been found to accompany the installation of the contra.

The Star Contra-Propeller Company are also developing a patent of Professor Haas, of Hamburg, which consists in fitting guide blades in front of the propeller. The aim of this device is to rotate the water in the opposite manner to that imparted to it by the propeller. Trials on a tug have established the efficacy of the device, which amounts to practically the same saving as the contra-propeller. This fact was also established by research at the Hamburg tank. Experiments with both devices in combination are being carried out. Three sister ships building at the Deutsche Werft are to be experimented upon in this connection. One vessel will have the contra in front of the propeller, one behind it, and one will not be fitted with the contra. The contra in front of the propeller should be especially convenient practically for twin and other multi-screw vessels. Its installation has been definitely shown to reduce the pitching of the vessel in heavy weather, and hence further increases the average service propulsive efficiency. This was especially observed in the cases of the sister ships *Paris* and *Biarritz* belonging to Fred Olsen & Co., of Christiania. The *Biarritz* was fitted with the contra while the *Paris* was not, and in the same heavy weather and wind direction the speed of the *Paris* fell from 10 knots to 3, while the *Biarritz* was able to maintain a speed of from 6 to 7 knots.

The manœuvrability of vessels fitted with the contra is also definitely increased. In the case of the *Grotius*, a 10,000 tonner, belonging to the Stoomvaart Maatschappij Nederland, of Amsterdam, the time taken to turn right about with rudder hard over was 5½ minutes without the contra, while with it only 3 minutes were necessary. Vessels which steered badly without the contra, steer much better after being fitted with this device.

The possibilities of the device are very definite, and when the cost of its installation can be saved by 250 days' running there is no doubt that many shipowners will be tempted to adopt it.—*Werft Reederei, Hafen*, June 22, 1922.

Stability of Passenger Vessels.

The problem of stability has received considerable attention in the Continental press of late, and in this article Geheimrat Rudloff especially considers the comparative stability of narrow and wide passenger vessels in the damaged condition. He points out how marine casualties have always been an incentive to the more detailed

study of the subject, and that present development consists in finding the solution to easy rolling and adequate initial stability. Dealing with the evolution of German design, the case of the first *Deutschland* is considered. This vessel was narrow and was well formed for minimum frictional and wave-making resistance. Her metacentric height was small and permanent ballast had to be used. The ship, however, was comfortable. The *Tirpitz* is next referred to. She is a much more recent vessel with larger beam and metacentric height than the *Deutschland*.

These two vessels are compared from the interesting standpoint that a vessel should have preferably zero metacentric height in the arrival condition. First the general theory of damaged condition stability is gone into. Formulæ are developed which bring out clearly the ballast righting effect and the fluid upsetting effect of the water entering the damaged compartment. In narrow vessels such as the *Deutschland* the ballast effect preponderates over the fluid effect and thus even in the damaged condition the vessel is quite stable. With the wider vessels the fluid effect preponderates, but on inclining, the increasing stability of the ship is generally sufficient to counteract this effect. Nevertheless, with these wider vessels an initial metacentric height is necessary to maintain the upright condition, and thus with them the arrival condition of zero metacentric height should not be approached. In connection with his investigations the author shows that the damaged stability increases with length of compartment, thus showing the comparative unimportance of stability in determining the safe spacing of bulkheads.

The case of the bulge ship is also examined, and in particular the *Cap Polonio*. The damaging of the bulge compartment produces a list which can be only eliminated by counter-flooding. An interesting suggestion is made as to the setting up of a central bureau in which all experience obtained by builders and owners could be shared and analysed. By this means the best type of ship will be gradually evolved. The question whether permanent ballast is justified in narrow ships because of the better damaged stability of these latter, as compared with wide ships with no ballast, could then be decided.—*Geheimrat Rudloff, Werft, Reederei, Hafen*, March 7/22, 1923.

Merchant Ships and the Classification Societies.

The aim of this article is to trace the development of merchant ship construction, principally in its relation to the influence of the classification society. The early and coffee-house days of these societies are referred to and the beneficial influence of technical education on their early and promiscuous methods is pointed out. The technical progress in the structural design of ships, made possible through the researches of the late Sir Edward Reed and Mr. William John, is acknowledged. The various distinct strength problems entering into design, *i.e.*, longitudinal, transverse, local and torsional, are outlined, and the manner in which the classification societies endeavoured to secure that these considerations were adequately respected is discussed. In this connection the numerals of the various societies are contrasted with each other. The development of better longitudinal distribution of material is discussed. This improvement refers, of course, to the thickening of deck and sheer strake with its consequent influence in lifting the neutral axis into a more symmetrical position.

Next, attention is directed principally to the development of the Germanischer Lloyd Regulations. In particular, the construction of widely spaced pillars is considered. The tendency is not merely to consider these pillars as supports, and thus incapable of transmitting bending moments, but to make them an integral part in the whole transverse structure. In the final number of the article the politics of the classification society are discussed. The suggestion which has been made in certain quarters as to the State control of the societies is commented upon, and the opinion expressed that their present private enterprise, being commendable, is preferable.—*F. Jadaschke, Schiffbau*, June 20-27, July 4-11, 1923, pp. 591, 609, 627; 9 pp.; 5 ff.

Flettner Rudder Trials of the T.S.M.S. "Odenwald."

The decision of the Hamburg-Amerika Line to adopt the Flettner rudder in their recently completed motorship *Odenwald* naturally required very careful experiments being carried out in order to test fully whether their enterprise was justified. The experience previously gained by the Flettner Company on the *Frigido* was considerably supplemented by researches carried out at the Hamburg tank, and this enabled the design of the *Odenwald's* rudder to be accomplished with some confidence in spite of its considerable size. The construction of the rudder has already been described in the English press, but in this article the features governing the scantlings and proportions of the main and auxiliary rudders are discussed in greater detail than in previous articles. The comparative weights of steam, electric and Flettner installations are supplied for the *Odenwald*. Without the auxiliary gear these amount to 34·55, 24·63 and 13·47 tons respectively. The auxiliary gear for steam and electric amounts to about 3·7 tons, while for the Flettner it amounts to 4·23 tons. The appreciable saving in weight with the Flettner is thus evident.

In the testing of the rudder, apart from its actual smoothness of working, several questions arise upon which information is necessary. These are the following:

(1) What is the maximum angle to which the Flettner rudder may be turned?

(2) What influence has a comparatively small movement from the maximum angle on the manœuvrability compared to an ordinary rudder?

(3) How do the effects of the ordinary and Flettner rudders compare at the same angle?

(4) How does the Flettner rudder work at slow speeds?

(5) How does it work when going astern?

To answer these questions it was intended to experiment upon the *Spreewald*, a previously completed sister ship to the *Odenwald*, but bad weather prevented the trials being made. Thus the comparison had to be effected by using the Flettner as an ordinary rudder on the *Odenwald*.

Only four hours were available for the turning trials, but nevertheless very complete information of the tactical diameters at low and full speed, with and without the Flettner rudder in action, for various angles of helm, was obtained.

One very important effect brought out by the experiments was that whilst ordinary rudders require an angle of 35 to 40 deg. for their maximum turning effect, which is really due to the vessel's drift angle influencing the flow to the rudder, the Flettner rudder automatically adjusts itself to the drift angle and requires a smaller angle of helm.

The trials showed that so far as the Flettner rudder was concerned everything came up to expectation. Several mechanical transmission difficulties were, however, experienced in the axiometer gear owing to friction and faulty gearing. On the vessel's first voyage these were eliminated, and reports from the captain show that the installation left nothing to be desired.

When it is remembered that the *Odenwald* is a 9,000-ton d.w. ship the significance of the Flettner rudder success will be realised.

The article, which gives very complete information, is excellently presented from the scientific point of view, and in itself forms an interesting contribution to our knowledge of the manœuvrability of ships. *Prof. F. Horn, Werft, Reederei, Hafen*, June 22, 1923, p. 343; 12 pp.; 20 pp.

A STEAM REFRIGERATING PLANT—*Contd. from p.* 307.

part of the evaporator (*a*) is driven by a pump (*f*) into the distribution pipes where its refrigerating power is utilised: the brine is returned after being warmed into a tank (*h*), whence it is drawn up again into the evaporator, owing to the vacuum existing in this latter, through the pipes (*i*) and the nozzle (*b*). The "pouring down" of brine in the evaporator is carried out through a perforated plate (*c*). The vaporised water is replaced in the brine circuit by means of a complementary water supply. A single engine (*k*) drives the above-named pumps.

The refrigerating ejector or ejectors can be supplied with dry saturated steam at a very low pressure. The ejector of the condenser requires dry saturated steam at a pressure which is not lower than 3 kg. per sq. cm. (say 43 lb. per sq. in.). When the required temperature for refrigeration is not lower than 0° C. water may be substituted for brine. The dimensions of the complete plant shown in the drawings on page 307 are: Length, 5·26 m.; breadth, 4 m.; height, 4 m. The total weight is approximately 18 tons. The power absorbed by the brine, circulation and exhaust pumps amounts to about 25 h.p. The number of frigories* obtained per hour per kilogramme of steam used for a temperature of circulating water of 30 deg. C. should be about 40. It is reported that a big French steamship company is contemplating the adoption of this type of refrigerating machine on several of its ships.

* A frigoric is the amount of heat which must be abstracted to reduce the temperature of 1 kg. of water 1° C.

RECENT PATENTS RELATING TO MARINE ENGINEERING.

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No. 183,336. Turbines, &c.

Gurney, J., Ridgewell, Halstead, Essex. June 21, 1921. No. 16934. [*Class* 110 (*iii*).]

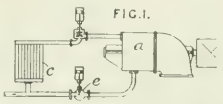
Radial-flow type; working fluid supply.—Steam entering the stator through a steam pipe impinges, through passages, on blades in the rotor, which is fixed by radial arms to a transmission shaft. The total outlet area of the rotor is less than the total outlet area of the stator, which is, in turn, less than the cross-sectional area of the steam pipe.

Reference has been directed by the Comptroller to Specifications 23740/95 *and* 26650/97.

No. 196,910. Turbines.

Akt.Ges. Brown, Boveri et Cie, Baden, Switzerland. April 13, 1923. No. 10134. Convention date, April 26, 1922. [*Class* 110 (iii).]

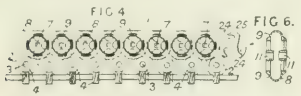
Working fluid supply; regulating.—In turbine working with superheated steam and into which at high loads live steam is admitted without passing through the first stage or stages, this additional steam is less superheated than the main steam so as to avoid thermal distortion of the casing, &c. For example, the additional steam which is admitted at high loads to an intermediate stage of the turbine *a* by the usual valve *e* does not pass through the superheater *c* for the main steam. In a modification, the additional steam is passed to a low-pressure turbine arranged in a separate casing and on the same or a different shaft from that of the high-pressure turbine. The additional steam may pass through a part of the superheater; it may be cooled before admission to the turbine by, for example, injecting water therein, or by using it as a means of intermediate superheat for the main steam.



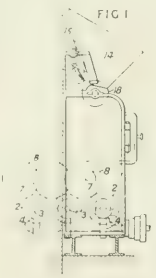
No. 197,342. Furnaces.

Petterd, J. W., 118, Bambra Road, Caulfield, and Watson, L. J., 52, Acland Street, St. Kilda, both in Melbourne, Australia. May 7, 1923. No. 12275. Convention date, May 6, 1922. Not yet accepted. Abridged as open to inspection under Section 91 of the Act. [*Class* 51 (i).]

Fire-bars and grates; fuel, feeding.—A furnace grate comprises rotary corrugated sectional bars 8, Figs. 1 and 4, supported on



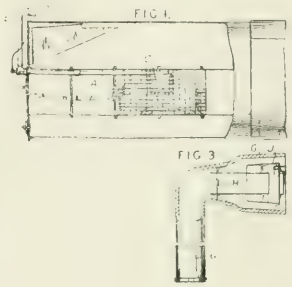
driving-rollers 2 which are mounted on shafts 3 driven by worm-gearing 4. The rollers 2 may be plain or corrugated. The bars 8 comprise a number of hollow sections, of the form shown in Fig. 6, each having a divided boss 11 received at the sides and engaging with the shaft 7. Air supplied beneath the grate may pass into and through the sections by way of passages 9. Rotary sectional ash-ejector 25, provided with pockets 24, is arranged at the rear of the grate. Fuel is fed to the front end of the grate from a hopper 14 provided with a sliding door 15 and one or more feeding-rollers 18. The speed of rotation of the bars at different parts of the grate may be varied.



No. 197,746. Furnaces.

Atkins, A., 4, Trefoil Road, Wandsworth, London. February 22, 1922, No. 5231. [*Class* 51 (i).]

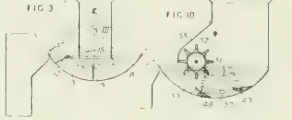
Air, supplying; smoke, consuming; baffles.—In smoke-consuming apparatus for furnaces of the kind comprising a secondary air conduit extending through the front of the furnace to a secondary combustion chamber at the rear and through which the air is induced by a steam jet, the inlet end of the air supply pipe is enlarged at G^1, Figs. 1 and 3, and provided with internal baffles comprising a cup-shape hood J and a tube H supported by brackets and arranged to cause the air to take a tortuous course and thus reduce the noise created by the action of the steam jet which is arranged at the junction of the vertical tube G and horizontal tube A. The steam nozzle is forked so as to deliver on each side of a vertical partition arranged in longitudinal channels provided in the pipe A, the discharge end of which is open at the underside and delivers downwardly into a chamber C with a perforated floor.

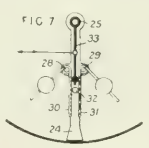


No. 197,847. Furnaces.

Marks, E. C. R., 57, Lincoln's Inn Fields, London.—(*Nisseu, N. F.; 7, D1, Mannheim, Germany.*) *June 14, 1922, No. 16501.* [*Class* 51 (i).]

Ashes, removing.—Ash-discharging apparatus for furnaces comprises a water trough disposed below the outlet of a funnel forming the ash-pit, in which trough a shovel or the like suspended from a fulcrum oscillates, the height of the shovel relatively to the depth of water being small to prevent jamming. The ashes may be removed from both sides of a trough suspended from the funnel, or as shown in Fig. 3, from one side only, the shovel 9 being a flap hinged to an oscillating arm and raised by fingers 12, pivoted to side-rails 13, on the return stroke. The flap 9 is held raised till the supporting arm is in the position III when it resumes its normal position. Hinged flaps 15 are fitted to the bottom edges of the funnel 7, and a constant water level is maintained by connecting the trough 8 by a flexible pipe to a float-controlled tank. The shovel may be arranged to slide along its supporting arms to override obstructions, and brushes may be fitted to its edges to prevent ashes from collecting at the sides of the trough. As shown in Fig. 7, the shovel 24 is resiliently driven, being freely suspended from the shaft 25 and provided with counterweighted levers pivoted at 28, 29. The shovel is oscillated by the arm 33 which engages the arms 30, 31 of the weighted levers, allowing the shovel 24 to remain stationary if too great a resistance is met. In a modification, the weighted levers are suspended from the arm 33, and carry the shovel 24 along by engaging the stop 32. One side of the funnel may be continued down to the trough, the ashes being discharged from one side only of the trough 53 by wedge-shaped shovels 48, 49, as shown in Fig. 10. The supporting arms of the shovels may be connected by stays 50, 51, and a rotating cylinder 52 with radial arms assists in discharging the ashes. A hinged flap 55, which conforms to the shape of the cylinder 52, provides an air-seal. The discharged ashes may be removed by a travelling conveyor serving a number of furnaces.



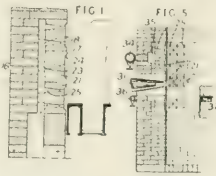


No. 197,671. Furnaces.

Drake Non-Clinkering Furnace Block Company, Incorporated, 5, Beekman Street, New York, U.S.A.—(*Assignees of Priebe, E. B.; 120, Roosevelt Avenue, Inwood, Long Island, New York, U.S.A.*) *May 2, 1923, No. 11879. Convention date, May 12, 1922. Not yet accepted. Abridged as open to inspection under Section 91 of the Act.* [*Classes* 51 (i) *and* 87 (i).]

Walls; air, supplying.—In furnaces burning solid, liquid, or pulverulent fuel, air under pressure is injected into the fuel bed, or

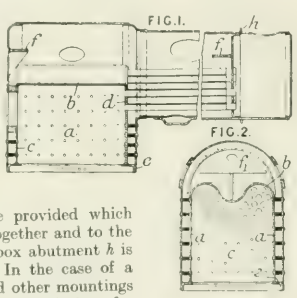
into the combustion chamber, through refractory blocks built into the walls and having air passages tapering from both ends towards a constriction. Fig. 1 shows a part of an underfed furnace with outer and inner walls 16, 17 separated by a space 18 to which air is supplied under pressure. The inner wall 17 comprises refractory blocks 21 provided with tapering constricted air passages 25 communicating with the space 18 and with the combustion chamber. The blocks may be provided with spacing lugs 23 and with shallow gutters 24 at the discharge ends of the air passages. Fig. 5 shows the blocks applied to the wall of a furnace into which fuel is injected through nozzles 31. The blocks 21 are arranged above and below the fuel nozzles, and air under pressure is supplied to the wall spaces 35, 37 from pipes 34, 36 provided with regulating valves to control the supply of air at different levels.



No. 197,407. Steam Generators.

Robson, P. W., Dunelm House, Church Lane, Lincoln. February 11, 1922, *No.* 4110. [*Class* 123 (ii).]

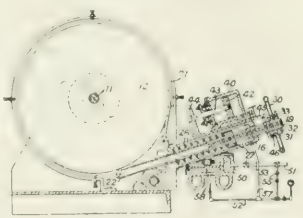
Locomotive-type boilers; fire-boxes; joints; stays.—In a locomotive-type steam generator the fire-box sides *a* and seamless crown *b* constructed from one piece of metal are welded to the end plates *c*, *d*. Preferably the fire-box is welded to a foundation ring *e* which projects inwardly to carry the fire-bars, and is riveted to the boiler shell. The crown *b* is corrugated, as shown, so as not to distort the prepared edges of the plate before welding. Stiffeners for the shell are provided which consist of plates *f*, welded together and to the shell. An external smoke-box abutment *h* is also welded to the shell. In the case of a portable boiler, seatings and other mountings may be provided for the accommodation of a prime mover and other accessories.



No. 197,489. Towing Ships.

Metcalf, F., 2063, *Adelbert Road, Cleveland, and Dalgleish, E.*, 17818, *Clifton Boulevard, Lakewood, both in Ohio, U.S.A. March* 30, 1922, *No.* 9192. [*Classes* 78 (v), 103 (i), *and* 114.]

In steam towing machines with automatic braking mechanism, a spring-controlled brake holds the predetermined load, such spring being adjustable, and means are provided for automatically releasing the brake on the load being exceeded. On the shaft 11 carrying the hawser drum is mounted a brake wheel 12 with contracting bandbrake 21, the end 22 of the latter being attached to an operating rod 19. This rod passes through the casting 16 and is screwed to take a nut 27 which coacts with a spring 26 to maintain normally a given pull on the brake band. On the outer end of the rod is another screwed boss with hand wheel 30. When this boss is screwed down to contact with the end of the casting 16, further movement results in a positive pull on the brake rod 19 independently of the spring 26. A lock nut 32 is provided with a catch 33 for holding it definitely against the boss. The hand wheel boss has an annular groove 31 which is encircled by an arm 46 on a sliding member 45 which has a bridge piece 44 to which is secured the rod 43 of a piston 42. The pipe connections to the valve chest 50 of the towing engine include a main supply 51 and a bye-pass 52 to the outlet side, and from the latter passes a branch 57 to the cylinder 40. The throttle valve 58 is coupled to the brake drum so as to be moved thereby when the brake is not holding the drum. In operation, the main valve 53 is closed and the bye-pass valve 55 is opened sufficiently to make up losses due to condensation. With the connection between the drum and valve 58 broken and the nut 27 slacked back, the hawser pays out to the desired extent when the valve 53 will be opened and the load picked up. The nut 27 is then adjusted to hold the load, the main valve 53 shut down, and the valve 58 coupled to the brake drum. When an overload occurs, the line pays out, the valve 58 is moved, and high pressure steam passes to the cylinder 40 whereby the rod 19 is moved in opposition to the spring 26 to put off the brake. The brake remains off until the line is recovered, whereupon the brake is reset by the spring.



No. 197,428. Steam Generators.

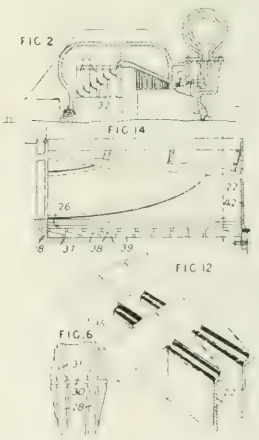
Domenico, S. de, Nictheroy, Rio de Janeiro, Brazil. February 17, 1922, *No* 4708. [*Class* 123 (ii).]

Casings; Settings.—In a steam generator having external flues, the gases first pass to a chamber a^2 beneath the boiler from whence they pass to an upper chamber a^5 by means of passages a^4 arranged one on each side of the boiler and at the centre of the length thereof. The upper chamber communicates with the chimney. The casing forming the flues is made of metal plates separated by non-conducting material and provided with cleaning doors.

No. 197,873. Turbines.

Metropolitan-Vickers Electrical Company Ltd., 4, *Central Buildings, Westminster.*—(*Westinghouse Electric & Manufacturing Company, East Pittsburgh, U.S.A.*) *July* 18, 1922, *No.* 19714. [*Class* 110 (iii).]

Blades and the like.—The wide low-pressure reaction blading described in Specifications 182775 and 183429 which receives elastic fluid axially and discharges it peripherally, or peripherally and laterally at a small angle, is formed with curved ribs or other deflector surfaces which extend from blade to blade. When the wide blading comprises a series of sections suitably assembled the deflectors are secured to the sections before being assembled. In Fig. 6, deflector plates 30, made as single pieces or in sections are shaped, to fit grooved supports 31 on the blade sections 28. The plates 30 may be bowed so that when forced into the supports 31 they will brace the blades and permit of differential expansion. Fig. 2 shows a single guide member 32 for each blade section 22, the members 32 being arranged successively lower from the inlet edge of the first blade section to the rear edge of the last section. To reduce vibration, the wide blades 22, Fig. 12, are secured to reinforcing members 35 which consist of flat annular strips fitting slots in the blade tips and arranged radially of the blades. Fig. 14 shows a method of connecting the blades 22 to the rotor 18. The blade 22 has a dovetail root 26 fitting a slot in the rotor. A groove 37 at the base of the slot receives wedges 38, 39 which force together the inclined surfaces of the blade root and of the slot. An end plate 42 contacts with the last wedge 38 of each series and holds the wedges in position.



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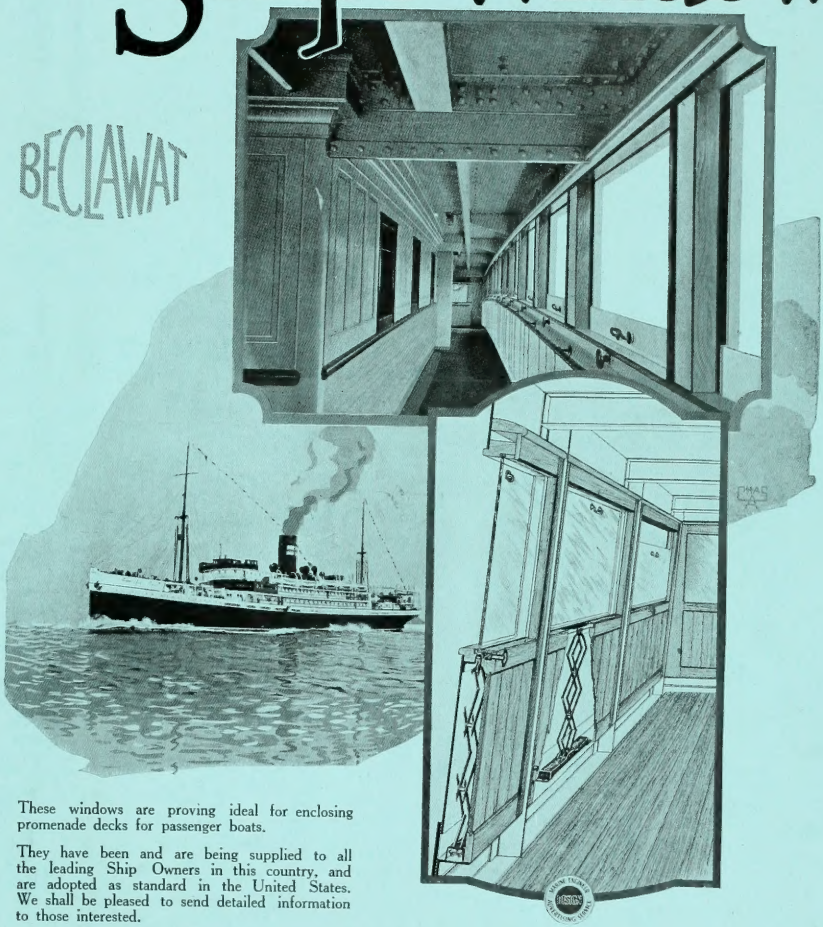

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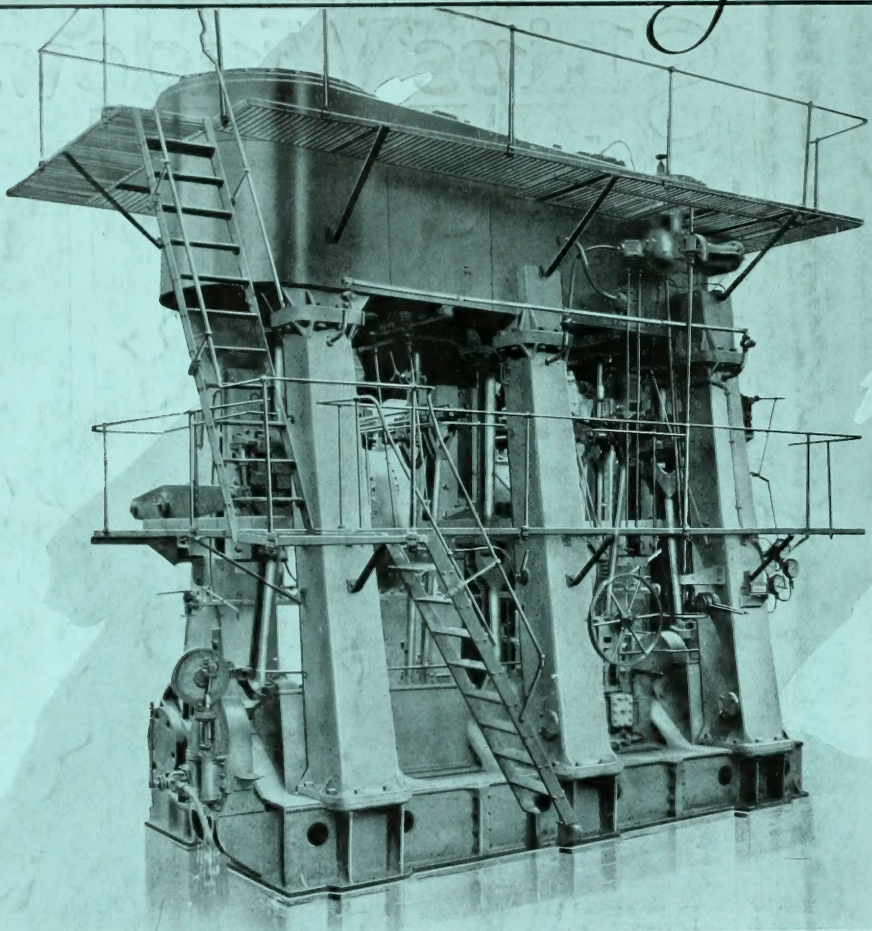

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